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**Cover Photograph:** Blue-headed Rock-thrush  
*Monticola cinclorhynchus*  
By Clement Francis M.



# Editorial

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## DNA-Barcoding – a new tool to look at the diversity of life

Counting, classification and naming come naturally to human beings. From time immemorial, human beings have been naming and classifying life forms based on existing knowledge and the culture of the region. Modern scientific classification of species started with the development of binomial nomenclature by the Swedish botanist Carolus Linnaeus (1707-78). Till now, approximately 1.7 million species of plants and animals have been named (excluding microbes), and it is said that there could be 10 million species in the world. Thousands of new species are described every year, particularly invertebrates. Even in the well-known vertebrate groups, such as birds and mammals, new species are being discovered with increasing frequency, mainly in the tropics.

Earlier, species were mainly described based on their morphological features, including skeletons. In recent time, a new method – DNA barcoding or DNA taxonomy – has been developed to identify species based on their DNA sequence. In brief, the barcode of life is a short DNA sequence, from a uniform locality on the genome, used for identifying species. The proponents of DNA barcoding claim that ‘it will help people quickly and cheaply recognize known species and retrieve information about them, and will speed discovery of the millions of species yet to be named’. They have given ten main reasons for Barcoding Life (<http://phe.rockefeller.edu/barcode/docs/TenReasonsBarcoding/pdf>). We list a few of them here. Barcoding can identify a species from bits and pieces, such as morphologically unrecognizable products derived from protected species or tissue pieces of bird strikes to aircrafts. Even plant material in processed foodstuffs can be identified, which will greatly help in the quality control of foodstuff and traditional medicine. The second important reason and a great improvement of the traditional taxonomic approach is that Barcoding can identify a species in all life stages, from eggs, larvae, seed, pupa, adult, flower, leaf, root etc. This will help in controlling trade of protected species and the products derived from their various life stages, which are sometimes difficult to identify. Barcoding also allows relatively rapid identification of candidate species, which may turn out to be a new species, on which necessary morphological and taxonomic research can be focused. DNA barcoding can also unmask look-alikes. Many harmful insects masquerade as harmless ones, so once we identify the cheaters, necessary initiatives can be taken to control them. Barcoding will also help us preparing the ‘life-trees’ – the phylogenetic similarities, differences and evolutionary relatedness among taxa.

Before we go ahead and start analyzing specimens, we have to prove that DNA barcoding is effective in distinguishing between intraspecific and interspecific mtDNA variation. Fortunately, some recent studies are proving that barcodes can distinguish more than 95% of species (Ward *et al.* 2005; Hajibabaei *et al.* 2006). In an often-quoted paper, Hebert *et al.* (2004) have shown that in the 260 North American bird species, mitochondrial gene Cytochrome C Oxidase 1 (COI) variation between species was much greater than that within species. They found that differences between closely-related species were, on an average, 18 times higher than the differences within species. They also found that most of the species did not share the same barcode from those of any other species. Interestingly, their research also led to identification of cryptic species, which were earlier considered to be single species. This was further confirmed when their morphology and songs were analyzed. In 17 sets of species with overlapping barcode (Kerr *et al.* 2007), it was found that it could be due to three reasons: some may be recently diverged sister taxa where COI has not accumulated sequence differences, secondly, these species could be sharing mtDNA due to hybridization, and thirdly some of the species showing overlapping may be single species.

Kerr *et al.* (2007) have shown that “most provisional species were small to medium-sized, plainly coloured birds, whereas most species with overlapping barcodes were large and/or brightly coloured, which might reflect a natural taxonomic tendency towards under-splitting inconspicuous birds and/or over-splitting more conspicuous species.” This is amply proved by the study of phylogeny of all species and nearly all subspecies of *Seicercus* and representatives of all subgenera in the *Phylloscopus* species of warblers (Olsson *et al.* 2004) and *Acrocephalus* genus (Leisler *et al.* 1997).

Recent DNA studies and genetics have confirmed the unity of the human being as single species, *Homo sapiens*. Comparison of COI barcode sequences shows that we differ from one another by only one or two base pairs out of 648, while we differ from the Chimpanzee (our closest relatives) at about 69 locations and the Gorilla at about 70 locations. Barcoding studies have also proved that there are two species of the Orangutan, and not one.

Bird taxonomy of the Indian subcontinent is going through radical changes, not only in nomenclature, but also in classification (e.g. Grimmett *et al.* 1998) and taxonomic upgradation of subspecies to full species or splits (e.g. Rasmussen and Anderton 2005). Rasmussen and Anderton (2005) have made 198 species-level changes in South Asia, which include many species splits within the region, splits within extra-limital species, and relocation of the race. For example, about 218 endemic bird species have been recorded from South Asia. In India, 18 subspecies have been upgraded to full species level, bringing the total to 79 fully endemic birds in India. The taxonomic status of some endemic species is not yet clear, and there is dispute over the status of some subspecies or races. Perhaps, DNA barcoding would help in settling such taxonomic uncertainties.

The Indian Council of Agricultural Research, New Delhi has asked the National Bureau of Fish Genetic Resources (NBFGR) to undertake an ambitious project to develop DNA barcoding of the Indian fish species. The scientists of NBFGR have already developed barcodes for about 50 fish species. This project is expected to go a long way for identification of species, subspecies and populations of our fish resources, which will also help in sustainable utilization, management and conservation.

There is a Consortium for the Barcode of Life (CBOL) whose aim is to have an international collaboration of natural history museums, herbaria, biological repositories and biodiversity inventory sites, together with academic and commercial experts in genomics, taxonomy, electronics, and computer sciences to speed up the compilation of DNA barcodes of all life forms. It also aims to establish a public library of sequences linked to named specimens, and promote development of portable devices for DNA barcoding. For more information visit: <http://barcoding.si.edu> and <http://www.barcodinglife.org>

Until now only two studies have been carried out using the mtDNA technique on Indian birds, e.g. Large-billed Reed Warbler *Acrocephalus orinus* (Bensch and Pearson 2002; Round *et al.* 2007), and a new species of Scimitar-Babbler from Myanmar (Rappole *et al.* 2005). Genetech Institute, Colombo, Sri Lanka is likely to take up the responsibility of DNA barcoding of Sri Lankan birds. In the current scenario of rapid habitat changes, declining avifauna of the Indian subcontinent, and taxonomic confusion of many species, there is an urgent need to take up DNA barcoding of the Indian avifauna for their long-term protection. According to Jathar and Rahmani (2006), out of the 79 endemic Indian birds species, three are Critically Endangered, one Endangered, 14 Vulnerable, three Data Deficient, 15 Near Threatened, 27 Least Concern, and 16 require revision of their conservation status. Some of the endemic Indian birds have very limited distribution. For example, the Nilgiri Blue Robin *Myiomela major* and the White-bellied Blue Robin *Myiomela albifentris* were earlier considered as subspecies of the White-bellied Shortwing *Brachypteryx major*. Rasmussen and Anderton (2005), based on morphological and vocal differences, have treated both as full species, and have also placed them under *Myiomela* and not under *Brachypteryx*. In this case, there is taxonomic shift and taxonomic upgradation of the species. This taxonomic upgradation is of great conservation concern, because both species are found in a tiny range in the southern Western Ghats – the White-bellied Blue Robin is confined to densely wooded streams and Shola forests from Palni to Ashambu Hills of Kerala and Tamil Nadu, south of the Palghat Gap, mostly above 1600 m, while the Nilgiri Blue Robin is a resident bird of the Nilgiri Hills and the nearby Bababudan and Bramhabiri Hills, north of the Palghat Gap. Both are considered Vulnerable by BirdLife International (2007). The Barn Owl *Tyto alba* is one of the most widespread birds in the world and it is fairly common, with no threat of extinction. BirdLife put it in the Least Concern category. It is widespread in India, including the Andaman and Nicobar islands. Earlier, the individuals found in the Andamans were considered to be a distinct subspecies *Tyto alba deroepstorffi* (Baker 1927, Ripley 1961, Ali and Ripley 1969). Inskipp *et al.* (1996), Grimmett *et al.* (1998) and Kazmierczak and van Perlo (2000) recognized two subspecies: *stertens* found in the whole Indian subcontinent, and *deroepstorffi* found in the Andaman Island. However, Rasmussen and Anderton (2005) have treated the subspecies of the Andaman as a full species, *Tyto deroepstorffi*, based on the distinct morphological differences described by König *et al.* (1999). If DNA barcoding further corroborate that it is a full species, it means that we have to re-evaluate its conservation status. Similar is the case of the Andaman Coucal *Centropus andamanensis*. From being a subspecies of the Brown Coucal *Centropus sinensis* (Ali and Ripley

1969), it is now elevated to a full species status, *Centropus andamanensis* by Rasmussen and Anderton (2005). With the change in taxonomic status, we have to evaluate the conservation status, mainly due to the small distributional range. It is also reported from the Coco and Table islands, and Myanmar. Rasmussen and Anderton (2005) have indicated that there is a “need for a comprehensive revision of *C. sinensis*.” Perhaps, taxonomy based on DNA will be able to solve such problems.

The All Birds Barcoding Initiative (ABBI) is an international effort that aims to establish a public reference library of DNA barcodes for approximately 10,000 known bird species. The ABBI library of avian sequences linked to museum specimens will speed up discovery of new species and aid in the conservation of biodiversity. Approximately 7,000 individuals from 1,500 species have been barcoded so far. The BNHS, with its collection of 29,000 bird specimens, and the Zoological Survey of India, with its vast collection, can play an important role in barcoding Indian bird species.

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ASAD R. RAHMANI  
GIRISH JATHAR



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PASTORAL PRACTICES, WILD MAMMALS AND CONSERVATION STATUS  
OF ALPINE MEADOWS IN WESTERN HIMALAYA<sup>1</sup>G.S. RAWAT<sup>2</sup><sup>1</sup>Accepted December 07, 2006<sup>2</sup>Wildlife Institute of India, Chandrabani, Dehradun 248 001, Uttarakhand, India. Email: rawatg@wii.gov.in

An ecological expedition was conducted across the alpine region of western Himalaya, from June to October 2004, to assess the conservation status of alpine meadows, current land use practices, patterns of plant species diversity and wildlife use. This paper deals with the findings pertaining to pastoral practices, abundance of wild mammals and status of alpine meadows under varying intensity of livestock grazing. Barring 3-4 protected areas (PAs), most of the alpine meadows were heavily grazed during summer. Abundance of wild mammals was very low in heavily grazed and degraded PAs. Unless management authorities rationalize livestock grazing, in consultation with the local communities, several PAs would fail to meet conservation objectives, and alpine meadows would further degrade, leading to environmental disaster in the region.

**Key words:** alpine meadows, ecological expedition, habitat degradation, livestock grazing, pastoral practices, western Himalaya, wild mammals

## INTRODUCTION

The alpine zone occupies nearly 33% of the geographical area in the Himalayan region and represents one of the most fascinating biomes, well known for its biological, geo-hydrological, aesthetic and cultural values. This zone is separated by a distinct treeline towards lower elevation that lies around  $3300 \pm 200$  m above msl in the western Himalaya, and  $3800 \pm 200$  m above msl in the eastern Himalaya. Diversity of life forms, structure and species composition of alpine vegetation has always attracted a large number of naturalists, phyto-geographers and ecologists (e.g., Mani 1974; Rau 1975). The most striking feature of the alpine vegetation is an abundance of herbaceous plants along narrow climatic gradients exhibiting interesting patterns of adaptations to harsh environments, short growing season and relatively recent Palaeo-history (Körner 1999; Vishnu-Mittre 1984). Though highly fragile and dynamic, the alpine habitats not only support diverse groups of fauna, but also form the upper catchments of the Himalayan rivers that serve as lifeline for millions of people along their lower basins. Hence, the health and integrity of the alpine ecosystems has direct bearing on the life-support system, environmental stability, biodiversity and human welfare in the region.

The alpine meadows of western Himalaya have been used for livestock grazing by a large number of agro-pastoral communities for several centuries (Tucker 1986). Other human activities in the alpine areas include extraction of wild medicinal plants for local as well as commercial use, pilgrimage, recreation such as trekking, camping and skiing. Broadly, there are two categories of meadows in the alpine zone of

Himalaya: (i) alpine moist meadows on the south facing slopes of Greater Himalaya dominated by herbaceous formations, locally termed as *Bugyal* in Uttarakhand, *Kanda* in Himachal Pradesh and *Marg* in Jammu and Kashmir, (ii) alpine dry pastures located in the rain shadow zone or trans-Himalayan zone characterized by dry scrub and desert steppe dominated by graminoids (Rawat and Adhikari 2005). The two regions differ considerably in terms of plant community composition, primary productivity and history of grazing by domestic and wild ungulates (Mishra 2001; Bagchi *et al.* 2004). Although the alpine meadows play an important role in relieving the grazing pressure on the forests and the grazing land of the lower altitudes, increased livestock and overuse has led to degradation of alpine habitats (Rawat 1998). Several ecologists have pointed out that the alpine meadows in many parts of the Greater Himalaya have been overused and degraded (Negi *et al.* 1993; Sundriyal 1989; Shah 1988). It has also been established that extensive grazing by migratory livestock negatively affects the habitat and abundance of ungulates (Sathyakumar *et al.* 1993; Bhatnagar *et al.* 2000; Vinod and Sathyakumar 2005). Nevertheless, livestock grazing in the alpine areas of the Himalaya is likely to continue as major land use for a long time, in the absence of better livelihood options for local communities. Depending on changing socio-economic conditions of the local people, livestock composition and grazing pressures have changed in many areas. This calls for a landscape level assessment of grazing pressure, wildlife abundance and status of meadows.

This paper deals with the pastoral practices, livestock densities and abundance of wild mammals across the alpine landscape in western Himalaya based on a recent ecological

expedition. Conservation status of the alpine meadows under varying intensity of livestock grazing has been discussed. The major objectives of the expedition were to (i) study the patterns of plant species diversity across environmental gradients, (ii) quantify the availability of wild medicinal and aromatic plants (MAPs) in the alpine region, (iii) assess the ecological condition of the alpine habitats *vis-a-vis* current land use practices, and (iv) document the wildlife use of alpine meadows along the survey route. The results of the expedition for the state of Uttaranchal (now Uttarakhand) are given in Rawat (2005).

## STUDY AREA AND METHODS

An ecological expedition across the alpine region of western Himalaya was conducted from June to October 2004 covering the states of Uttarakhand, Himachal Pradesh and Jammu and Kashmir. Over 2500 km was traversed on foot covering an altitudinal zone of 3300-5500 m above msl on either side of the Greater Himalaya. The starting point of the expedition was near the Indo-Nepal border in Uttarakhand (30° 06' 31.7" N and 80° 50' 04.7" E), ending near Amarnath in Kashmir Himalaya (34° 12' 49.4" N and 75° 27' 48.8" E). A large number of forest officials and field staff of State Forest Departments joined the expedition at various places, in addition to a few volunteers. The expedition route covered a number of wildlife sanctuaries (WLSs), national parks (NPs), community owned forests or grazing lands (*Van Panchayat*), reserved forests (RFs) and unclassified state forests (USFs). On an average, a distance of 15-20 km was traversed in a day. Over 300 sites were sampled for 10 x 1 sq. m random quadrants for the analysis of species diversity following Rawat *et al.* (2001). The landscape level survey allowed an assessment of a wide range of vegetation formations and habitats, such as glaciated valleys, plateaus, moraines, high passes, scree slopes, glacial outwash, avalanche traps, stream courses and stable slopes. Environmental parameters, such as soil depth, soil texture, altitude and aspect, were noted and geographical co-ordinates at each sample point were recorded using Global Positioning System (GPS), to be analysed in detail at a later date. The major PAs visited during the survey include Askot WLS, Nanda Devi Biosphere Reserve, Valley of Flowers NP, Kedarnath WLS, Gangotri NP, Govind WLS, Churdhar WLS, Raksham Chitkul WLS, Rupi-Bhaba WLS, Seichu-Tuan WLS, Rungdum WLS and Thajwas WLS. The route followed during the survey is shown in Fig 1.

Information on the pastoral practices and number of livestock (species wise) was collected along the survey route through informal interviews with the herders and local forest officials. Legal and management status of the land in Biosphere

Reserves (BRs), NPs, WLSs, *Van Panchayat*, RFs, USFs were obtained from forest / revenue records. Information was also collected on the approximate area of the meadows, dominant vegetation types, intensity of human use and number of livestock and duration of grazing. Direct and indirect evidence of wild mammals were recorded along the survey route on a daily basis, aided by previous experience, local informants and available literature (Prater 1980; Menon 2003).

Conservation status of alpine meadows / vegetation was assessed along the survey route. From the herders' point of view, good pastures are characterized by dominance of palatable forbs, absence of weedy and unpalatable species, and an extensive area that could support larger herds. Ecologically, sites with better conservation status are those which represent the full range of alpine habitats (and microhabitats), without human induced soil erosion. About 162 meadows were rapidly assessed in terms of stages of degradation and one of the following categories was assigned to each: (a) Pristine meadows (climatic climax with least soil erosion caused due to anthropogenic activities), (b) Slightly degraded or intact meadows, (c) Moderately degraded meadows (gently undulating areas with short duration of grazing only by sheep and goats) (d) Heavily degraded areas characterized by heavy soil erosion and infested by spiny herbs (*Cirsium falconeri*, *C. verutum* and *Morina longifolia*), and unpalatable herbs (*Rumex nepalensis*, *Phlomis bracteosa*, *Hackelia uncinata* and *Osmunda claytoniana*), among others. These criteria are not applicable for assessment of alpine vegetation in the trans-Himalaya or closer to high alpine pioneer vegetation.

## RESULTS AND DISCUSSION

### Pastoral Practices

Five distinct pastoral practices are prevalent across the alpine landscape in the western Himalaya: nomadic, semi-nomadic, nuclear transhumance, trans-migratory and sedentary (resident). True nomadic pastoralism is practiced mainly by the *changpa* herders in the Changthang plateau of Ladakh, which lies outside the limits of current survey. The *gujjars* (the buffalo herders in the southern slopes of the Greater Himalaya and the Shivaliks) have over the years shifted from nomadic to semi-nomadic lifestyle. The *gaddis* and *bakarwals* of Himachal Pradesh and Jammu & Kashmir follow semi-nomadic lifestyle (only few members of a family move long distance with their livestock). Many agro-pastoral communities in Uttarakhand and Himachal Pradesh practice nuclear transhumance (a part of the family moves to higher altitudes closer to treeline along with surplus cattle). Trans-migration (seasonal altitudinal movement by the entire family



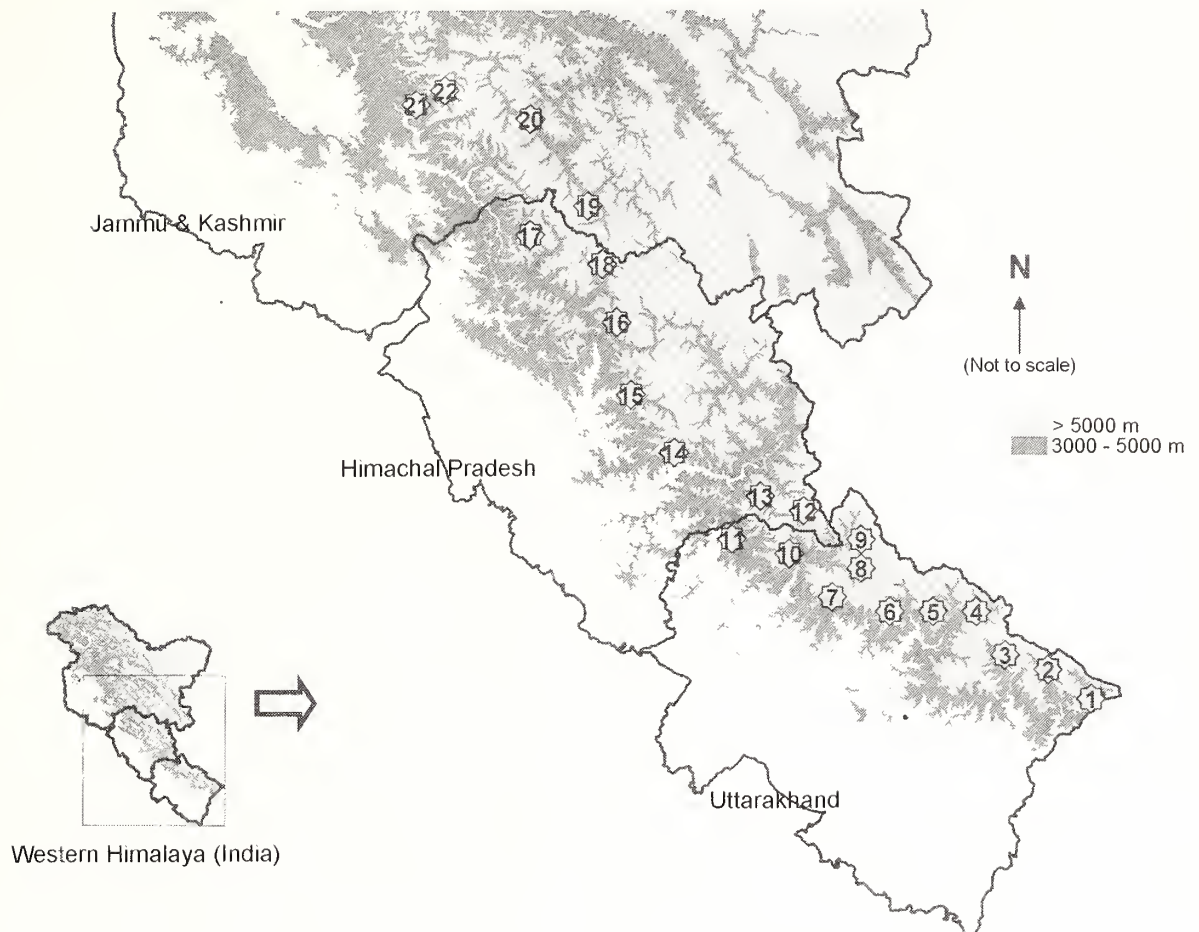


Fig 1: Route followed and localities covered during the alpine expedition (2004)

1 = Byans Valley, 2 = Darma & Askot WLS, 3 = Johar Valley, 4 = North of Nanda Devi BR, 5 = Valley of Flowers NP, 6 = Kedarnath WLS, 7 = Khatling, 8 = Gangotri NP, 9 = Nilang Valley, 10 = Gidara, 11 = Govind WLS, 12 = Raksham Chitkul WLS, 13 = Sangla Valley, 14 = Rupi-Bhaba WLS, 15 = Bhrigu lake & Rohtang, 16 = Paton Valley, Lahul, 17 = Pangi, 18 = Myar Valley, 19 = Padam, Zaskar, 20 = Surru valley, 21 = Thajwas WLS, 22 = Amarnath

along with the livestock) is practiced mainly by the *bhotiya* communities in various parts of Uttarakhand, such as Byans, Darma, Johar and the upper basins of Alaknanda and Bhagirathi. Presently only 20-30% of the original households and only few members in each family along with most of the livestock, except milch cattle, migrate to the distant alpine valleys, in the process making available several alpine pastures for other communities belonging to the lower parts of the state (Uttarakhand) and the *gaddi* herders from Himachal Pradesh. In the high altitude villages of Kinnaur, Spiti, Lahul, Pangi and Zaskar there is round the year grazing by the resident livestock, in addition to migratory livestock. In Chamoli, Tehri, Uttarkashi and Kinnaur districts, several families drive their scrub cattle to sub-alpine and alpine areas for free grazing during the snow free period (June-October). This practice leads to faster degradation of meadows and will

need immediate reversal if conservation has to succeed in and around the nearby PAs.

Densities of livestock in the alpine meadows of three states have been compared in Table 1. The survey revealed that livestock densities in the alpine areas of Uttarakhand ( $33.92 \pm 10.01$  /sq. km) were much higher compared to Himachal Pradesh ( $17.55 \pm 9.25$  /sq. km) and Jammu & Kashmir ( $10.45 \pm 12.33$  /sq. km). It is to be noted that the herders from Chamba, Kangra and other parts of Himachal Pradesh take their sheep and goats either towards the Sarchu plains in Jammu and Kashmir or to the alpine valleys of Uttarakhand, which is ascribed to degradation of alpine pastures and shortage of forage in the state (personal interviews with the herders). Highest densities of sheep and goats were observed in the alpine areas of Govind WLS (50 sheep and goats, and 10 bovids and equids per sq. km) followed by Thajwas WLS

**Table 1:** Density of livestock in alpine meadows of Western Himalaya

Parameters	Uttarakhand	Himachal Pradesh	Jammu & Kashmir
Geographical Area (sq. km)	53,485	55,670	222,240
Area under Alpine Vegetation (sq. km)**	8,524	17,296	131,851
Density of sheep & goats in alpine areas (no. / sq. km)	33.92 ± 2.65	17.55 ± 9.25	10.45 ± 12.33
Density of bovids & equids in alpine areas* (no. / sq. km)	2.48 ± 2.65	1.62 ± 2.46	1.42 ± 1.27

(Source: \*State Animal Husbandry Departments, \*\*Lal *et al.* 1991)

(31 sheep and goats, and 20 mules per sq. km) and Rupin-Bhaba WLS (23 sheep and goats, and 3-4 bovids per sq. km). Except core areas of Nanda Devi NP, Valley of Flowers NP and part of Gangotri NP, all PAs had high grazing pressure (mean density of sheep and goats 28.23 ± 17.90 /sq. km, and bovids and equids 2.15 ± 2.87 /sq. km). Interestingly, mean livestock densities during peak summer months outside the PAs (22.21 ± 19.16 sheep and goats /sq. km and 1.97 ± 1.81 bovids and equids /sq. km) were lower compared to densities within PAs, though the differences are not significant (Table 2).

#### Abundance of wild mammals

Of about 51 species of wild mammals reported from the alpine region of western Himalaya (Menon 2003), only 25 were seen or recorded along the survey route. The 16 species sighted were Himalayan Tahr (*Hemitragus jeulalicus*), Himalayan Musk Deer (*Moschus chrysogaster*), Blue Sheep (*Pseudois nayaur*), Goral (*Neorhaedus goral*), Asiatic Black Bear (*Seiuarctos thibetanus*), Himalayan Yellow-throated Marten (*Martes flavigula*), Red Fox (*Vulpes vulpes*), Himalayan Marmot (*Marmota himalayana*), Long-tailed Marmot (*Marmota caudata*), Himalayan Weasel (*Mustela sibirica*), Himalayan Palm Civet (*Paguma larvata*), Tibetan Woolly Hare (*Lepus oiostolus*), Royle's Pika (*Ochotona roylei*), Large-eared Pika (*O. macrotis*), Mountain Vole (*Alticola argentatus*) and Lesser Bat (*Hipposideros* sp?), while the other 8 species, namely Hangul (*Cervus elaphus hanglu*), Serow (*Nemorhaedus sumatraensis*), Himalayan Brown Bear (*Ursus arctos*), Tibetan Wolf (*Canis lupus chanco*), Snow Leopard (*Uncia uncia*), Himalayan Stoat or Ermine (*Mustela erminea*), Tibetan Wild Ass (*Equus kyang*) and Golden Jackal *Canis aureus*) were confirmed based on indirect evidence such as skin, horns, skull, tracks, droppings and reliable local informants. One of the significant findings of this survey is the direct and indirect evidence of a few trans-Himalayan mammals (Woolly Hare and Tibetan Wild Ass) along the northern fringes of Uttarakhand. There is no report of these species from Uttarakhand in published literature. In Nilang Valley (part of Gangotri NP) local people reported presence of Tibetan Argali or Nayan (*Ovis amnoui*

*hodgsoni*) and Wild Yak (*Bos grunniens* locally known as 'doug'). Further status surveys would be required to confirm their presence in the interior areas of this Park. It is also to be noted that inner drier ranges of Uttarakhand exhibit characteristics of trans-Himalaya rather than Greater Himalaya. This calls for a slight modification of current biogeographic classification suggested by Rodgers and Panwar (1988).

Highest abundance of wild ungulates was found en route to Gangotri glacier (part of Gangotri NP). In a walk of 13 km, 65 Blue Sheep in four groups were sighted. This valley (c. 250 sq. km) has been protected from livestock grazing since the last decade and according to a recent survey, it supports a population of 270-300 Blue Sheep (Wildlife Warden, Gangotri NP, pers. comm.). Estimates for Himalayan Musk Deer and other mammals are not available from this valley. Upper catchments of Girthi Ganga (part of Nanda Devi BR in Uttarakhand) also showed higher abundance of Blue Sheep, Himalayan Marmot and Snow Leopard compared to all other sectors along the survey route. The shepherds reported frequent killings of domestic sheep and goats by Snow Leopard in this area. A major portion of this landscape represents alpine arid pasture (steppe vegetation), which is contiguous with the Tibetan plateau. Livestock grazing in this valley is carried out only for a short period (July-August). Other PAs west of Govind WLS had a much lower abundance

**Table 2:** A comparison of livestock densities within PAs and outside PAs within alpine region of Western Himalaya\*

Parameters	Inside PAs (N = 14)	Outside PAs (N = 13)
Approximate area surveyed (sq. km)	3205.00	3685.00
Density of sheep & goats ± SD (no. / sq. km)	28.23 ± 17.90	22.21 ± 19.16
Density of bovids & equids ± SD (no. / sq. km)	2.15 ± 2.87	2.06 ± 2.38

\*Note: Independent samples test: No SD in the densities of sheep and goats (t=0.842; df=24.487, 95% confidence interval) and bovids and equids (t=0.200; df=22.130, 95% confidence interval)



of wild mammals. According to forest officials, livestock killing by Brown Bear in Govind WLS has been a major cause of concern. The alpine areas of Seichu Tuan WLS in Pangi support small populations of Himalayan Tahr, Himalayan Ibex, Brown Bear and Himalayan Musk Deer. Official estimates of Ibex and Himalayan Tahr in this sanctuary are 250-300 and 50-60 respectively, but there is also a heavy influx of livestock (>2500 sheep and goats) during summer. Raksham-Chiktul, Churdhar and Thajwas sanctuaries exhibited the least abundance of wild mammals. Incidentally, Churdhar and Thajwas sanctuaries are <100 sq. km in size and have very high livestock densities.

The alpine areas outside the current PA network also varied considerably in terms of wildlife abundance. As expected, interior localities free from human habitation and low grazing pressure had higher abundance of wild mammals. However, such areas are vulnerable to poaching, unless regulated by the local communities themselves. A hill slope opposite Niti village in Uttarakhand (buffer zone of Nanda Devi BR) has been protected by the villagers from livestock grazing for the last 8-10 years, mainly for fodder and medicinal herbs. This slope offers excellent sub-alpine and alpine habitats. In a walk of about 2 km, 12 piles of Himalayan Musk Deer pellets were encountered on this slope. It was also interesting to find three active colonies of the Himalayan Marmot in the same area. Occurrence of the Himalayan Musk Deer and the Himalayan Marmot in the same habitat has not been reported from other parts of the Himalaya. Other examples of community regulated resource use and restriction on poaching were seen in Johar valley (Uttarakhand), Upper Sural valley in Pangi sub-division (Himachal Pradesh) and Rungdum area of Surru Valley (Jammu and Kashmir). Excessive grazing and rush for high value MAPs, such as the Palm Orchid (*Dactylorhiza hatagirea*) and Caterpillar Mushroom (*Cordyceps sinensis*) by local communities in the Greater Himalaya of Uttarakhand are the major factors affecting wild mammals during summer. In Byans Valley (eastern Uttarakhand) local people reported recovery of wild ungulates during the past 8-10 years due to stringent laws, conservation awareness and a drastic reduction in trans-migration. The scenario is, however, different in interior parts of Lahul where grazing pressure has increased over the years. A four day walk (c. 80 km) along Myar valley (Lahul) yielded no direct sightings of mammals and only few indirect evidences of Blue Sheep, Ibex and Red Fox.

### Status of the meadows

Based on general appearance and species composition, the moist meadows can be grouped into the following six categories (i) Tall herbaceous formations, (ii) Short forbs, (iii)

Matted shrubs / shrubberies, (iv) *Danthonia* grasslands, (v) *Kobresia* meadows, and (vi) Cushionoid vegetation. Characteristic features of these meadows are described by Rawat (2005). Vegetation cover and number of species per unit area were the highest in tall and short herbaceous meadows, especially in the high rainfall zones of Greater Himalaya (cover >90% and species richness 35-45 per site). *Kobresia* meadows are generally considered climax formations on the south facing high alpine (>4000 m above msl) slopes. Of the 162 random sites assessed for stages of degradation within the moist meadows of the Greater Himalaya, only 6 sites (3.7%) were classified as 'pristine meadows'. Intact (slightly degraded), moderately degraded and heavily degraded sites constituted 18.5, 39 and 30.8% respectively. Thirteen sites (8%) showed signs of recovery from heavily degraded stages to moderate stage. The meadows grazed by heavier livestock (especially buffaloes, cattle and equids) for a longer period were the most degraded.

Conservation status of alpine meadows was best within a few PAs, namely Valley of Flowers NP, parts of Nanda Devi BR, Kedarnath WLS, and interiors of Tehri-Uttarkashi districts in Uttarakhand. The sub-alpine slopes of Thajwas WLS and Amarnath were dominated by a least preferred, unpalatable grass *Stipa sibirica*. Some of the heavily degraded alpine sites included Dayara, Auli, Panwali Kantha, Kedarkantha in Uttarakhand, Churdhar, Sangla Valley, Rohtang-Bhrigu Tal, Rupi Bhaba WLS in Himachal Pradesh, and Amarnath, Thajwas areas in Kashmir. The alpine slopes in Sangla Valley and many parts of Lahul are vulnerable to encroachment, especially for cultivation of cash crops, such as Green Pea (*Pisum sativum*). Within the Zaskar range, conservation status of pastures was best along the left bank of Surru river, especially from Rangdum to Nun Kun base. These slopes were reported to have moderate livestock grazing and support a reasonably good population of Blue Sheep. Thajwas WLS is grazed by more than 2500 sheep and goats and over 200 ponies during summer (June-September). According to the wildlife authorities, upper reaches of Thajwas support a small population of Hangul (Kashmir Stag), Himalayan Musk Deer and Asiatic Black Bear. The Sanctuary is contiguous with upper parts of Dachigam NP. The alpine slopes on way to Amarnath are frequently broken due to avalanches and landslips. The estimated area of alpine meadows in the vicinity of Amarnath is about 250 sq. km and over 3000 sheep and goats and 100 mules graze on the alpine slopes. In addition, every year the Amarnath area is visited by over two lakh pilgrims. Trampling of the alpine vegetation, overgrazing by pack animals and littering the trail with non-biodegradable waste have led to severe degradation of this alpine habitat.



## CONCLUSION

Landscape level survey of the alpine zone in the western Himalaya revealed several facets of pastoral practices, distribution and abundance of wild mammals and conservation issues. Livestock density in the alpine areas of Uttarakhand was higher compared to those of Himachal Pradesh and Jammu and Kashmir. There were no significant differences in the livestock densities within and outside the PAs, barring a few PAs in Uttarakhand. Influx of large herds from Himachal Pradesh to the alpine areas of Uttarakhand during the recent decades, and increase in the population of heavy livestock, especially around treeline are causes for concern and need to be addressed urgently.

Low abundance of wildlife in most of the areas can be attributed to habitat degradation and loss due to excessive grazing by migratory and resident livestock. Larger PAs and remote valleys allow adequate spatio-temporal separation among domestic livestock and wild ungulates. Such areas had higher abundance of wild mammals and better conservation status of meadows, provided there was low pressure from tourism and pilgrimage. Based on the habitat characteristics and evidences of trans-Himalayan mammals (direct and indirect), it is recommended that northern parts of Uttarakhand be included under Biogeographic zone IB (Trans-Himalaya) by making appropriate amendments in the current biogeographic classification by Rodgers and Panwar (1988).

A large number of meadows (31% of the survey localities) were heavily degraded due to extensive grazing by livestock. 39% of the meadows were moderately degraded and only a

few (8%) sites represent pristine meadows. Quantitative information on the extent of degradation within and outside various PAs would be necessary in order to monitor the condition of meadows or formulate recovery plans. Management authorities need to rationalize livestock grazing within high altitude PAs in order to pursue conservation objectives and check further degradation of the alpine meadows in the Himalaya.

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NEW BIRD DESCRIPTIONS WITHOUT PROPER VOUCHER SPECIMENS:  
REFLECTIONS AFTER THE BUGUN LIOCICHLA CASE<sup>1</sup>RAGUPATHY KANNAN<sup>2</sup><sup>1</sup>Accepted December 22, 2006<sup>2</sup>Department of Biology, University of Arkansas – Fort Smith, Fort Smith, Arkansas 72913, USA.

Email: rkannan@uafortsmith.edu

A new species of *Liocichla* (Aves: Timaliidae) was recently described (Athreya 2006) without the submission of a proper voucher specimen. The author did not collect one on grounds that the species may be rare. The publication evoked dismay among museum ornithologists who feel that the species should not have been formally described and published without a proper voucher specimen, and that the bird may not be as rare as believed. There is also a feeling outside of museum circles that the requirement of voucher specimens may be obsolete and that museum scientists are insensitive to conservation concerns. This essay analyses this controversy and attempts to present the science behind this sensitive issue, to facilitate future decision making. Topics covered include: similar cases in the past and the criticisms they have evoked; why voucher specimens are indispensable for ornithological research and conservation; why there may be no viable alternatives; how scientific collecting makes little or no impact in most bird populations; whether bird journals should accept new descriptions without proper voucher specimens; and how modern museum ornithologists are partners rather than adversaries in the cause of bird conservation.

**Key words:** New descriptions, voucher specimens, Museum collections, ICZN, Bugun Liocichla

## INTRODUCTION

The recent description of the Bugun Liocichla *Liocichla bugunorum* (Athreya 2006) created a stir in the popular media world-wide, ostensibly because of the exquisitely pretty appearance of this bird. In the New World, most new bird descriptions make the cover of *Auk* or such journals, but not leading newspapers. But Athreya's paper also evoked frowns in the ornithological community, especially among the systematists who make their living studying avian diversity, describing new species, or dealing with taxonomic conundrums in ornithology, because this case represents one of the few instances in literature in which a new bird species was described *sans* a full museum specimen.

Athreya did not collect a specimen for fear that the species may be rare, and therefore resorted to describing the species primarily by using various photographs obtained from mist-netted birds. He satisfied the rules of the International Code of Zoological Nomenclature (ICZN) by obtaining and depositing feather samples. This case may have added fuel to the already widespread feeling that museum collections are no longer necessary for describing new species. Worse, in a country where bureaucratic hurdles for scientists are already formidable, the case may actually make getting scientific collecting permits tougher.

There also seems to be a general feeling in India (and elsewhere in the world) that museum scientists are zealously in pursuit of specimens, even at the expense of conservation. Some people, including some experienced birdwatchers, feel

that collections can jeopardize survival of species. More disturbing is the perceived transatlantic divide between conservationists and museum ornithologists. Having worked intensely on birds on both sides of the Atlantic, but not being a systematist myself, I decided to research this issue. I corresponded with leading avian systematists in the USA, and interviewed them personally. I read the extensive literature available on this topic. I also had this article reviewed by some of them (see Acknowledgements). This essay should hopefully yield better insights into the science behind the issue and dispel wrong notions that prevail.

First, I briefly present the cases in the past where new descriptions have been published in the absence of a specimen and the criticisms they have evoked. Then, I deal with the systematists' rationale for requiring specimens for new species descriptions and their arguments on why judicious bird collections make no significant inroads into bird populations. I then deal with the delicate questions of whether rare birds should be collected and if alternatives to collecting should be explored. I also tackle the mistaken notion that museum scientists are not conservationists, and briefly highlight how museum collections actually enhance research and conservation efforts in the long-term. Finally, I address the issue of whether bird journals should accept new descriptions without proper type specimens.

**The precedents: new bird descriptions without proper voucher specimens**

In at least four instances in the past, new birds have



been described using living specimens, of which I briefly describe below the two most recent. The other two (Collar 1999) are: Delacour and Jabouille's (1924) description of the Imperial Pheasant (*Lophura imperialis*); and Sclater's (1863) paper on *Gallicolumba bartletti* (= *G. criniger*).

A Malurine Wren, *Malurus campbelli* (Campbell's Fairy-Wren) was first described in 1983 from New Guinea, based solely on photographs of five mist-netted birds that were later released (Schodde and Weatherly 1983). Although they distributed "near life-size" prints to leading bird museums, the authors clearly violated ICZN rules which mandate "an animal, or part of an animal" to be collected and preserved in a museum as type material.

In August 1988, an unidentifiable bush-shrike was captured, photographed, video-filmed, and tape-recorded in central Somalia. The bird was apparently the only known individual of the species in the wild. Civil unrest forced the evacuation of the chief player(s) involved and the live bird was brought to Germany, where it was kept alive. The bird was then returned to Somalia in March 1990 (how it was transported internationally is unclear), but because the original area of capture was isolated by civil war, and because it "had hardly any suitable habitat left", it was not released back where originally captured, but instead was liberated far from the original place of capture on March 23, 1990, after more than a year in captivity. Smith *et al.* (1991) described it as a new species (Bulo Burti Boubou, *Laniarius liberatus*) based on DNA sequence data obtained from blood samples taken from the captive bird. The type material submitted included DNA and blood samples, plus some moulted feathers.

These two cases triggered a firestorm of criticism from systematists (LeCroy and Vuilleumier 1992; Peterson and Lanyon 1992; Banks *et al.* 1993; Winker 1996). The practice of neglecting the collection of proper voucher specimens was called 'sloppy science', and the practitioners were labeled 'misguided' (Winker 1996). Banks *et al.* (1993) even urged that "those who are unaware of or unwilling to abide by accepted principles and practices of systematics and taxonomy should excuse themselves from those aspects of ornithology." The rest of this essay addresses their chief concerns.

### **Why are Voucher Specimens needed for New Bird Descriptions?**

This question is relevant considering the widespread feeling that bird collections are leftover of the past and that they are no longer needed. Banks *et al.* (1993), in their scathing rebuke of new descriptions without type specimens, vehemently stressed the importance of defining a 'name' and associating it with an available 'type'. Many collection

opponents think that specimens are too primitive a way to 'document the presence' of a species, and that any possible gain in knowledge is simply not worth the killing of a bird. These people generally do not appreciate the enduring value of specimens, or the minute impact collecting has on bird populations. In an excellent and highly detailed paper, Remsen (1995) made powerful arguments on the importance of continued collecting of bird specimens to bird studies and conservation. Collections are not merely done to document the presence of a bird, but rather to act as a permanent archive from which an enormous amount of information can be gleaned in the long-term (Parkes 1963; Remsen 1995). Inquiries based on careful examination of museum skins spawn many unexpected and unanticipated surprises long after the specimens themselves are added to the museum drawers, ranging from delineation of new species or even new genera, to documentation of phenotypic change in short timeframes, to comparison of toxin levels over time (Remsen 1995; Rocque and Winker 2005; Winker 2004; Winker 2005). Charles Darwin recognized different species of finches in his collection only after his return to England, and even today, his collections are used by biologists (Diamond 1987). Museum specimens are indispensable not only to delineate past and present ranges of species and identify biodiversity hotspots for protection, but also as basis for entire fields of scientific endeavour (Foster and Cannell 1990). Even modern techniques, such as stable isotope analysis, have relied on archived museum specimens (Rocque and Winker 2005).

Without a proper voucher specimen, the taxonomic status of the newly reported *Liocichla* will always be open to doubt. Townsend Peterson, an accomplished systematic ornithologist and conservationist, expressed concern that describing new species without proper voucher specimens could lead to serious problems in double-description of species and confusion with nomenclature. In numerous instances, new bird species have been recognized and described only by careful scrutiny of museum specimens of a wide spectrum of bird species, both the one described and its allied forms. Diamond (1987) mentioned a case from Australia in which five new species, which would never have been recognized as distinct species, were described based only by a comparison of a series of museum specimens. For more on the indispensable nature of voucher specimens, see the examples in Bates *et al.* (2004).

So, one may ask, if voucher specimens are that important, why isn't the ICZN revised to explicitly state that? I posed the same question to the systematists. Peterson felt that the problem may be in the fact that even 'full' voucher specimens are only part of the bird, and that the Code already states that a part of the bird has to be deposited. Richard

Banks said that the provision that part of an animal can be used covers mammals (skull only in many cases) and invertebrates too. In fact, Banks added, in some invertebrate groups, a specimen must be virtually destroyed during the identification process, leaving little or anything for a type. The bottom-line: With so many exceptions and with such wide variation in minimally acceptable criteria for type specimens, the code is best left in general terms, to cover the entire range of zoological taxa.

### Why are Photographs and Feather samples insufficient for New Bird Descriptions?

Although the photographs that accompanied the *Liocichla* descriptions appear sharp and apparently serve their purpose, in general, photographs are not always reliable because they may not reveal critical characters and colour shades may not be true (Remsen 1995). Aspects such as the angle, light availability, quality of the device or film used, and the photographer's skill can influence the product. The photograph may also change through time. More disturbingly, many photographs can easily be doctored leaving open the possibility of scientific fraud. Also, colour descriptions are considered most reliable when standard colour charts (Smithe 1975-1981) are used in the field, which was not done in the *Liocichla* description. Photographs are also deficient in that they yield just a fraction of the information that can be obtained from a type specimen (Goodman and Lanyon 1994).

There was a time in the early 20<sup>th</sup> century and before, when bird illustrations (paintings) were sometimes used as the basis for new descriptions. This was before the tradition of the preparation of specimens was established. The ICZN recognizes and accepts this aspect of the past, emphasizing that the type is the specimen illustrated and not the illustration itself. But illustrations cannot be used now. To modern museum ornithologists, photographs without a voucher specimen are akin to such illustrations and may signify a step backward to an outdated system. With modern preservation methods available now, there is no need to return to the decidedly weaker historic methods.

Feather samples deposited as voucher material would have limited (if any) value, other than satisfying ICZN rules. Non-destructive sampling of this kind does not yield the long-term scientific benefits of proper type specimens (Christidis 1995; Rocque and Winker 2005).

### Does Modern Scientific Collecting Affect Bird Populations?

It is unclear whether or not scientific collecting played a role in the extinction of any bird species. In some cases, collecting along with deleterious practices, like logging, has contributed to demise of populations, for e.g. the Ivory-billed

Woodpecker *Campephilus principalis* (Jackson 2002). But modern scientific bird collecting makes little or no impact on most local bird populations. Remsen (1995) and Winker (1996) attributed anti-collection measures and the decline in numbers of museum specimens to a mistaken focus on conservation at the level of the individual rather than the population. Whatever little impact is generated by collecting has little import in the long-term because bird populations have generally shown to be very resilient (Lack 1954). Remsen (1995) provided some compelling figures: A typical common passerine of tropical forest undergrowth occurs at a density of one pair per five hectares, which translates to 20 pairs per sq. km. If proper habitat is available, a miniscule 10 x 10 km area can have 2,000 pairs of the species, which is "far more individuals than exist in all world's collections combined for most tropical bird species after more than 150 years of scientific collecting" (Remsen 1995). Collecting of birds for scientific and educational purposes contributes a mere 0.00011% to all human-caused avian mortality (Winker *et al.* 1991).

Also, given our knowledge of songbird population dynamics, mortality induced by collecting is not additive, but rather compensatory (K. Winker, pers. comm.; see next section), meaning, the few individuals collected by scientists become part of the population that would have died through other means such as disease or starvation, carrying capacity is not altered, and annual mortality of the population is not affected, i.e. about the same number will exist at the next breeding season, when the animals collected are replaced by new recruits that would otherwise have not bred into the breeding population (Remsen 1995; K. Winker, pers. comm.). There is no evidence that scientific collections result in additive mortality in birds.

### Should Rare Birds be Collected?

Remsen (1995) warned that collecting specimens could damage populations that are very small or those with poor recruitment rates, and wrote that modern scientists would object to collecting from these fragile populations. Does the new *Liocichla* represent such a population? The answer is: we don't really know because we do not have adequate population status data, and Athreya's decision to not collect one may even be justified given the unknown.

But many museum scientists would argue that Athreya squandered an opportunity for practicing sound science. Some of the systematists I interviewed or corresponded with said they *would* have collected a specimen had they been in his shoes. Kevin Winker, another accomplished museum ornithologist, wrote "Since Ramana Athreya first encountered the species in 1995, MANY have died, and collecting is not additive but rather compensatory mortality, so the natural



loss of individuals in this population has exceeded the impact that the collection of a type would have had.” Winker further added that in this case, with some creativity, we could have put forth the best conservation and best museum science by bringing several birds into captivity for a captive breeding program, and when the first individual died of old age, it could have been preserved and formed the basis for a new species description. He also suggested that by this time the new name could have been auctioned off to a high bidder and thus the species’ conservation (and, if I may add, the economy of the Bugun tribe that *Athreya* obviously cares about) placed on a firmer financial footing.

Townsend Peterson echoed similar sentiments. When I asked if he would have collected a specimen had he known the bird was very rare and that a collection could jeopardize the survival as a species, he replied “I sincerely doubt that these populations are so small. If your species really just had six individuals left, what is the probability that the describer saw all of them?” He added that he is almost certain that many more individuals exist, and for that reason would feel comfortable collecting one.

In an article criticizing the bush-shrike case, Peterson and Lanyon (1992) argued that, given what is known about the dynamics of songbird populations, “any songbird species represented by so few individuals, that a single individual represents a sizeable proportion of the breeding population, *will* be extinct in a very short span of time.” So what should the scientific world do if there is just one bird of a species left in the wild (or two or more of the same sex)? Wouldn’t it be better to collect a specimen, rather than for the species to vanish into thin air with no clear documentation of it having ever existed? Are we not better off having that mounted (albeit depressing) specimen of the extinct Great Auk (*Pinguinus impennis*) staring out of the glass case in that museum? Let posterity at least see in a museum what we have extinguished from the wild.

### **Why can’t some ‘Less Harmful’ Alternatives to Collecting be Explored?**

Museum scientists maintain that there simply is no viable alternative to collecting. Remsen (1995) analysed in depth the various proposed alternatives, from examination of live birds in hand, to obtaining photographs (see above) and blood and tissue samples, and methodically highlighted the drawbacks of every one of them, drawbacks that can only be solved by the collection of a museum specimen. Even such perceived non-harmful measures such as mist-netting<sup>1</sup>, bird-

ringing, and colour-banding (see Hagan and Reed 1988) are not as innocuous as they are touted to be. The annual mortality caused by ringing far exceeds that caused by scientific collecting (Remsen 1995). Handling can also cause birds to abandon the area (Poulin *et al.* 1994, as cited in Remsen 1995). As for the collection of molecular evidence, see the section on that topic elsewhere (below) in this essay.

### **Are museum scientists “blood-thirsty”?**

So, are Townsend Peterson *et al.* so singularly focused on getting specimens that they don’t care for conservation? Are they ‘obsessively’ arguing for collecting to keep their jobs? Remsen (1995) addressed these issues. He and others say that museum work enhances knowledge and awareness, and that this directly or indirectly impacts positively on bird conservation. “Many influential conservationists, from Theodore Roosevelt to Theodore Parker, collected and continue to collect museum specimens” wrote Remsen, and he added that Parker used specimens in more than 65% of his technical papers. Most modern museum scientists, according to Remsen, are also conservationists in practice and spirit, and most feel that the killing of birds for museums is “necessary but distasteful”. Museum scientists are as interested in the living bird as non-museum scientists, and almost all pursue other avenues of inquiry pertaining to live birds like vocalizations and ecology. The tally of specimens ‘bagged’ is not an index to the caliber of a museum scientist (Remsen 1995), contrary to Beane (1991), who claimed that “ornithologists are measured by the number of birds they have collected”.

As discussed earlier, some museum scientists would have readily collected the new *Liocichla*, a deed that conservation organizations would not have readily advocated. Collar (1999) described the rather unusual circumstances behind the bush-shrike case (having been the one who recommended that the shrike be kept alive) wherein a conservation organization (he heads BirdLife International) was seemingly at odds with museum science. Reading Collar’s (1999, 2000, 2003) papers and extensive commentaries on the topic, I am convinced, as he was, that the way out of this apparent conflict is for museums and conservation organizations to work interactively and not become too territorial in their missions.

One of my Indian colleagues, a seasoned birdwatcher and conservationist, called this push for voucher specimens an ‘American thing’, and lamented that “the fact that the bird is pretty rare does not bother them.” He referred to the Banks

<sup>1</sup>Townsend Peterson pointed out (by way of informal conversation) that one of the *Liocichla* pictures (Pic. 9) in *Athreya*’s (2006) paper depicted a bird with half-closed eyes – an apparent sign, he said, of fatigue or trauma. He hastened to clarify that he was not implying that the netters abused the bird. I added this footnote in relation to the point I raised about the perceived safety of bird netting.



*et al.* (1993) paper to support that assertion. But the fact is Banks' paper was endorsed by scientists from 18 countries<sup>2</sup> on both sides of the Atlantic. Another widely circulated statement summarizing the importance of scientific collecting was endorsed by 294 ornithologists from 61 countries, and only four ornithologists disagreed with the statement (Goodman and Lanyon 1994). For some excellent examples of conservation-oriented papers authored or co-authored by American museum ornithologists, see Remsen (1978), Remsen and Parker (1983), Osborne and Peterson (1984), Remsen *et al.* (1991), Peterson *et al.* (1993), Parker *et al.* (1993), Escalante-Pliego and Peterson (1994), Hernández-Baños *et al.* (1995), Remsen and Parker (1995), Johnson *et al.* (1998), Peterson and Navarro-Sigüenza (1999), and Peterson and Robbins (1999). There is, and should be, no transatlantic divide between museum science and conservation.

### Would molecular evidence not suffice?

I added this question, although it is not an issue with the current *Liocichla* case, because this question is increasingly asked in this era of DNA techniques. Hughes (1992a<sup>3</sup>), in a follow-up to the bush-shrike description, opined that in the case of new descriptions of species that are endangered, catch-and-release is the only ethical course to take. He added, "a DNA sample can potentially provide far more information about the relatedness of any organic species than a museum specimen could ever do." Peterson and Lanyon (1992) interpreted that comment as a call against museum collection (which Hughes [1992b] denied in his rebuttal) and pointed out that the bird was not described on the basis of DNA comparisons only, and that if the bird had not been distinct in colour and morphology, it would never even have been noticed. They pointed out that DNA studies cannot provide the suite of information that can be gleaned only *via* an examination of museum specimens. "The vast majority of the 9000+ currently recognized bird species is supported by a museum study skin", they wrote, and then ask rhetorically, "after over 90% of the world's bird species have been described, is it logical to select an entirely new form of documentation?" (Peterson and Lanyon 1992). For some specific Old World examples to illustrate why blood alone is not enough to decode taxonomic puzzles, see Bates *et al.* (2004).

My perusal of the literature convinces me that molecules and biochemicals complement, rather than replace, voucher

specimens. Winker (1996), in an excellent and widely-cited essay entitled 'The Crumbling Infrastructure of Biodiversity', wrote "Because ornithology has a skin-based taxonomy, the preservation of skins as vouchers is mandatory – and is simply good field science." Molecular data, he said, are the strongest when they accompany phenotypic evidence, and cited several key articles. Remsen (1995) also cited several papers that demonstrate that genotypic and phenotypic evidence when used in tandem can offer dramatic new insights into avian evolution. Therefore, to again quote Winker (1996), "Molecules give added scope, but will never serve as a replacement for a taxonomy based on two centuries of careful examination of phenotypes."

### Should bird journals accept new species descriptions without proper voucher specimens?

Banks *et al.* (1993) strongly recommended that editors of bird journals or 'other literature concerning birds' summarily reject and refuse to publish papers that attempt to describe new taxa without a proper specimen deposited in a museum. In an interview published shortly after the publication of the discovery, Ramana Athreya is quoted to have said "With today's modern technology, we could gather all the information we needed to confirm it as a new species. We took feathers and photographs, and recorded the bird's song." Many systematists would argue that full confirmation and the species' exact taxonomic status is possible only by a methodical examination of museum skins of various individuals of this and all related species in a museum setting. In light of all other comments he made on this subject (covered in this essay), Winker told me that no bird journal should accept a description of a new species without a type specimen. Peterson was more circumspect, saying, "The Code has clear guidelines about whether a publication qualifies, and I would suspect that *Indian Birds* does qualify." He said that Athreya should have written an article informing and documenting the discovery of the species, but should not have gone to the extent of formally describing it without a proper type specimen. He added: "Reviewers for a major ornithological journal... would likely have urged the author to collect a specimen as clear documentation of the species."

There is a precedent to informally reporting a putative new species. King *et al.* (1999) reported "An undescribed *Muscicapra* flycatcher" from Sulawesi, Indonesia, based solely

<sup>2</sup>Ironically, one of the signatories of the Banks *et al.* (1993) paper was R. Schodde, who authored the new Malurine Wren description without a voucher specimen (Schodde and Weatherly 1983). Schodde now chairs the Standing Committee on Ornithological Nomenclature of the I.O.C. (R. Banks, pers. comm.).

<sup>3</sup>Hughes, apparently lacking the eye for detail that taxonomists are known for, misspelled the generic name of the Bulo Burti Bush-shrike as "*Lanarius*" throughout the document.

on field observations, and wrote "A formal description of the species is not possible with this limited information." They added that they wrote the note "to call attention to its existence and to facilitate further study."

### CONCLUSIONS

I hope this essay enhances awareness of the science and sentiments behind the issue. The best end to the whole episode would, of course, be the obtaining of a proper specimen without jeopardizing the species' overall status. I am an ardent conservationist, but I must admit I was swayed by the arguments in favour of collecting a specimen right away. Given that Bugun Liocichlas have been around rather predictably in that same sanctuary for more than a decade, and given that it is a protected area with no immediate threat of habitat destruction, I am confident that the collecting of a specimen will have no long-term negative effect on the local population. But this is just my opinion based on perusal of literature and interaction with some experts 10,000 km away. The decision makers are those on ground zero and I wish them the best as they collect status information and other pertinent data, and as they negotiate bureaucratic problems (I am sure getting a collecting permit would not be easy). I also urge them to make their best decision based on sound science and conservation.

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## BIRD COMMUNITIES OF THE PROPOSED NAINA AND PINDARI WILDLIFE SANCTUARIES IN THE KUMAON HIMALAYA, UTTARAKHAND, INDIA<sup>1</sup>

AISHA SULTANA<sup>2,4</sup>, M. SHAH HUSSAIN<sup>3</sup> AND JAMAL A. KHAN<sup>2,5</sup>

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<sup>2</sup>Conservation Ecology Research Group, Department of Wildlife Sciences, Aligarh Muslim University, Aligarh 202 002, Uttar Pradesh, India.

<sup>3</sup>CEMDE, School of Environmental Studies, University of Delhi, Delhi 110 007, Delhi, India.

Email: mshahhussain@rediffmail.com

<sup>4</sup>Email: aishasultana28@yahoo.com

<sup>5</sup>Email: wsi@nde.vsnl.net.in

Two areas rich in avifauna, Vinaiyak and Pindari reserve forests in Kumaon, were surveyed in 1998 and 2000. A total of 165 bird species were recorded in Vinaiyak and 121 bird species were recorded in Pindari Reserve Forest. The diversity of bird species was highest in the oak habitat in Pindari both during pre-monsoon and post monsoon seasons, while in Vinaiyak it was highest in the oak habitat during pre-monsoon. The insectivore guild was dominant over all other guilds in both areas. Conservation problems are discussed briefly and recommendations made.

**Key words:** avian communities, species diversity, species richness, proposed sanctuaries, habitat types, conservation

### INTRODUCTION

The Himalaya, which supports many endemic and endangered plant and animal species, is divided into three parts, namely Eastern, Central and Western Himalaya. The Kumaon Himalaya marks the eastern limit of the Western section. The region has witnessed fast depletion of its forest cover and rich biodiversity in recent decades. Development in the area has fragmented the once continuous forest. Several studies of biodiversity status have been carried out, but they mainly cover vegetational aspects (Saxena and Singh 1982; Pangtey *et al.* 1982; Singh *et al.* 1984; Saxena *et al.* 1985; Saxena and Singh 1984; Samant *et al.* 1993; Rikhari *et al.* 1989; Dhar *et al.* 1997), while studies on the faunal component were lacking till recently. Kaul 1993, Shah Hussain *et al.* 1997, Sultana and Khan 1999, Sultana and Khan 2000 and Hussain *et al.* 2000 have reported birds and large mammals of Kumaon. These studies have identified areas rich in biodiversity. Sultana and Khan 1999 and Hussain *et al.* 2000 suggested that Pindari and Vinaiyak reserve forests be declared as wildlife sanctuaries, since they possess higher diversity of both flora and fauna compared to other locations in Kumaon.

Birds are important indicators of opportunities to conserve ecosystems. Moreover, assessment of bird communities can be utilized to develop conservation strategies for particular habitats or regions. The two areas of Kumaon studied here have been proposed as wildlife sanctuaries. Pindari has also been identified as an Important Bird Area in the Western Himalaya (Jhunjhunwala *et al.* 2001). The status of avian communities for these sites will be useful in preparing

comprehensive conservation strategies for the proposed sanctuaries.

### STUDY AREA

The study was conducted in Vinaiyak in the Nainital district, and Pindari in the Bageshwar district of Kumaon (Fig. 1). Both fall under the reserve forest protected area category.

#### Vinaiyak Reserve Forest

This Reserve Forest (29° 27' 45.4" N and 79° 24' 31.8" E) covers 15.32 sq. km. The elevation ranges from 1,900-2,623 m and represents Himalayan temperate forest (Champion and Seth 1968), with two broad habitat types, i.e. oak and mixed coniferous forest.

Plant genera include *Quercus floribunda*, *Quercus leucotricophora*, *Quercus semecarpifolia*, *Abies pindrow*, *Taxus buccata*, *Cedrus deodara*, *Cupressus torulosa*, *Rhododendron arboreum*, *Betula utilis*, *Picea smithiana* as dominant tree species, while major shrub species are *Arundenaria* spp., *Berberis aristata*, *Myrcine africana*, *Rubus biflorous*, *Indigofera heterantha*. The mammalian fauna includes Indian Wild Boar (*Sus scrofa*), Leopard (*Panthera pardus*), Barking Deer (*Muntiacus muntjak*), Sambar (*Cervus unicolor*), Goral (*Naemorhedus goral*), Himalayan Black Bear (*Selenarctos thibetanus*), Yellow-throated Marten (*Martes flavigula*), Red Fox (*Vulpes vulpes*), Kashmir Flying Squirrel (*Hylopetes fimbriatus*), Golden Jackal (*Canis aureus*), Rhesus Macaque (*Macaca mulatta*) and Common Langur (*Presbytis entellus*).

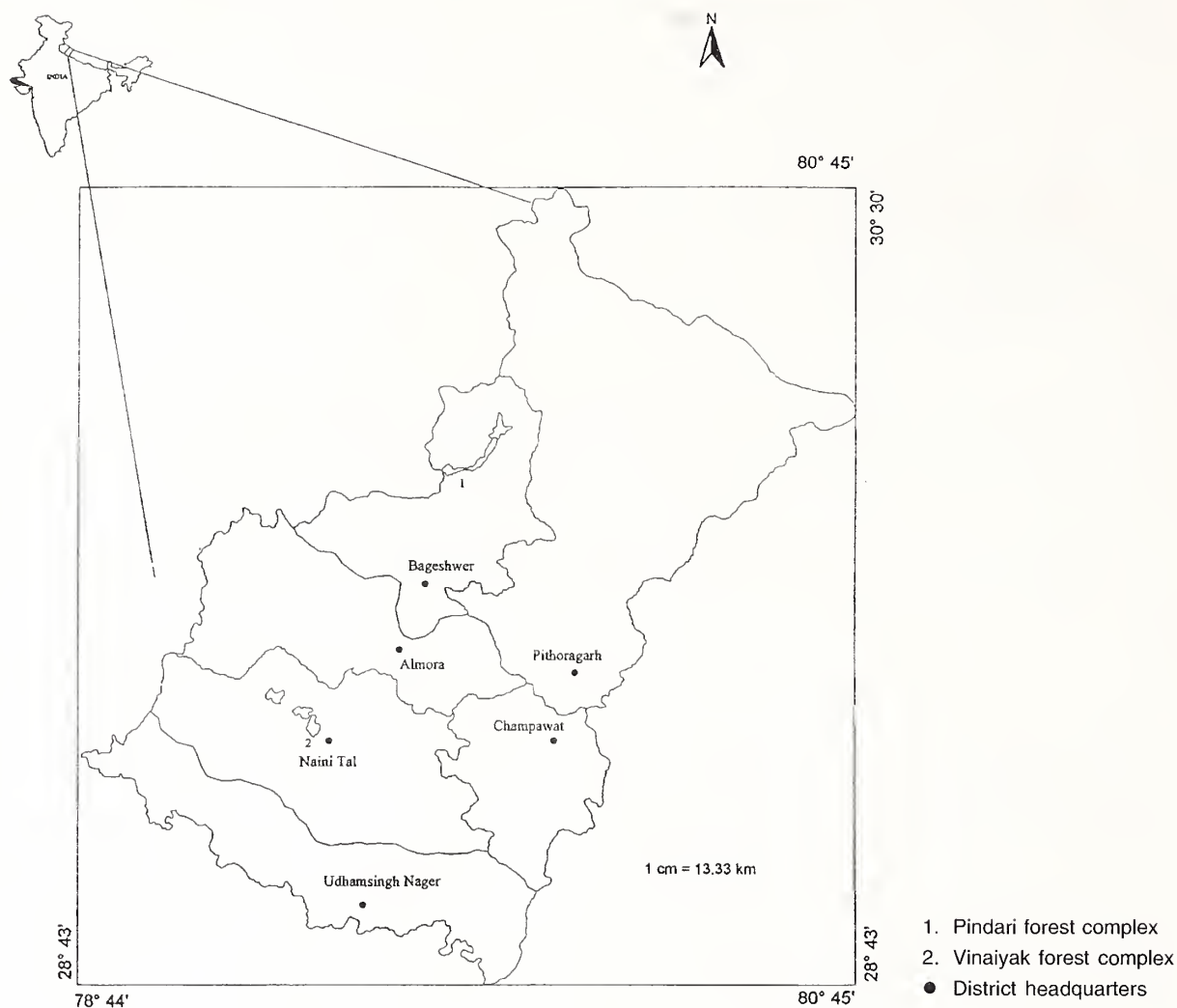


Fig. 1: Location of the proposed Pindari and Naina Wildlife Sanctuaries in the Kumaon Himalaya, India

### Pindari Reserve Forest

This Reserve Forest (30° 11' 11.3" N and 79° 59' 30" E) encompasses an area of 58.25 sq. km. Altitude ranges from 2,000 m to >4,000 m and it represents temperate (1,500-3,500 m) to alpine (>4,000 m) climatic conditions (Champion and Seth 1968). Being very close to Pindari, Kafni and Sunderdunga glaciers, the area experiences extreme weather conditions. There are three distinct seasons, summer (April-mid June), monsoon (June to September) and winter (October to March) (Adhikari *et al.* 1992). Mean temperature varies from 2° C (February) to 31° C (June) (Adhikari *et al.* 1992). The vegetation is moist temperate type (Champion and Seth 1968). The major tree species include *Quercus semecarpifolia*, *Abies pindrow*, *Taxus buccata*, *Betula utilis* in association with *Rhododendron barbatum*, *Acer caesium* and *Aesculus indica*. The dominant shrub species included *Arundinella nepalensis*, *Athyrium* spp., *Polystichum* spp., *Pteris cretica*, *Daphne papyracea*, *Urtica dioica* and

*Pyranantha crenulata*.

The area holds some endangered mammals, such as Musk Deer *Moschus moschiferus* (endangered), Himalayan Tahr *Hemitragus jemlahicus* (suspected to be endangered), Serow *Capricornis sumatraensis* (possibly endangered), Himalayan Black Bear *Selenarctos thibetanus*, Leopard *Panthera pardus*, and Snow Leopard *Uncia uncia* (endangered).

### METHODOLOGY

**Sampling of avian community:** Sampling was carried out in Vinaiyak Reserve Forest in the pre-monsoon (March-June) and post monsoon seasons (September-December) 1998, and in pre-monsoon season (April-May) 2000. In Pindari Reserve Forest, surveys were conducted during pre-monsoon season (March-June) 1998 and post monsoon season (October-November) 2000.

**Table 1:** Number of birdlists compiled in Vinaiyak Reserve Forest and Pindari Reserve Forest in different habitat types during pre-monsoon and post-monsoon seasons

Habitats	Oak	Mixed	Oak-mix	Oak-deg	Grl
<b>Vinaiyak</b>					
Pre-monsoon	101	107			
Post-monsoon	107	104			
<b>Pindari</b>					
Pre-monsoon	25	25	-	15	12
Post-monsoon	11	10	10	11	10

Oak-deg = Oak degraded, Grl = Grassland

Birds were sampled in stratified random manner. Two habitat types were identified in Vinaiyak Reserve Forest, namely oak and mixed-coniferous forests, ranging from 2,000 to 2,300 m; five habitat types were recognized in Pindari Reserve Forest, namely oak, mixed-coniferous, grassland (alpine pasture), oak-degraded and oak-mixed-coniferous forests 2,200 to 4,200 m. Sites were selected randomly within a habitat, ensuring that they were at least 100 m apart, to avoid overlap. Species richness counting method (MacKinnon and Phillips 1993) was used to assess overall density and richness of birds. Each bird list consisted of only 10 or 20 consecutive species seen, irrespective of distance covered or time spent. No species was included more than once on any list, but common species were listed on many different lists. Bird listing locations in the sampling area were repeated on different days. A total of 419 and 119 bird lists were compiled in Vinaiyak and Pindari respectively (Table 1). Birds in flight and nocturnal species were excluded. Data were not collected during rainfall and dense fog, but drizzle or a light breeze was accepted, as bird activity in the forest interior was not affected.

**Data analyses:** Data collected by species richness counting method were analysed by the species effort curves (Magurran 1988) to determine whether the area had been exhaustively covered. The time spent in each area was unequal, so data matrices were standardized following Zar (1984) to achieve normality and reduce heteroscedasticity.

Species richness (R1) was calculated following Margelef's richness index (Magurran 1988).

$S - 1/\ln N$  where  $S$  = Total number of species,  $N$  = Total number of individuals

Species diversity was calculated by Shannon-Weiner index (Magurran 1988).

$H' = - \sum p_i \ln p_i$  where  $p_i$  = proportion of individuals found in the  $i^{\text{th}}$  species

This index assumes that individuals are randomly sampled from an 'indefinitely large' population and all species

are represented in the sample (Pielou 1966).

Sorenson's similarity index (SI) (Magurran 1988) was calculated for different habitat types for both sites by the formula:

$SI = 2 \times \text{common species between two habitats} / \text{total number of species}$

This technique looks at the similarity of pairs of habitats in terms of presence or absence of species (qualitative data).

All species were classified according to status following Ali and Ripley (1987) and feeding guild, i.e. insectivore, omnivore, frugivore, granivore, nectarivore and carnivore as classified by Karr (1971).

The total number of species for each habitat was calculated by adding species from different lists compiled. All bird records were pooled to prepare a comprehensive checklist for both sites.

## RESULTS

A total of 199 bird species were recorded, of which 121 were encountered in Pindari, and 165 in Vinaiyak. A comprehensive checklist of all bird species along with information on habitat types was combined for both sites (Appendix). The MacKinnon curves reached asymptote level in each habitat at each reserve. This varied for different habitats and seasons. For example, in oak habitat of Pindari Reserve Forest, the asymptote was reached after 23 bird lists during pre-monsoon season, while during post monsoon months it was reached after nine bird lists (Figs 2, 3, 4 & 5).

Tables 2 & 3 show classification of 199 bird species by feeding guilds. The highest number of bird species belonged to the insectivore guild in all habitats, except in the grassland of Pindari where omnivores (45.45%) predominated. The contribution of insectivore differed between the seasons in all habitat types of Pindari, while it was the same for both habitats of Vinaiyak in both seasons.

**Table 2:** Classification of birds (percentage of species) according to their guilds in Vinaiyak Reserve Forest during pre-monsoon and post-monsoon seasons 1998

Guild	Pre-monsoon		Post-monsoon	
	Oak	Mixed	Oak	Mixed
Insectivore	53.28	52.70	53.42	52.77
Fruigivore	5.10	5.40	5.47	5.55
Carnivore	6.56	11.48	8.21	10.18
Grainivore	8.75	6.75	5.47	7.40
Omnivore	23.35	22.29	24.65	22.22
Nectarivore	2.91	1.35	2.73	1.85



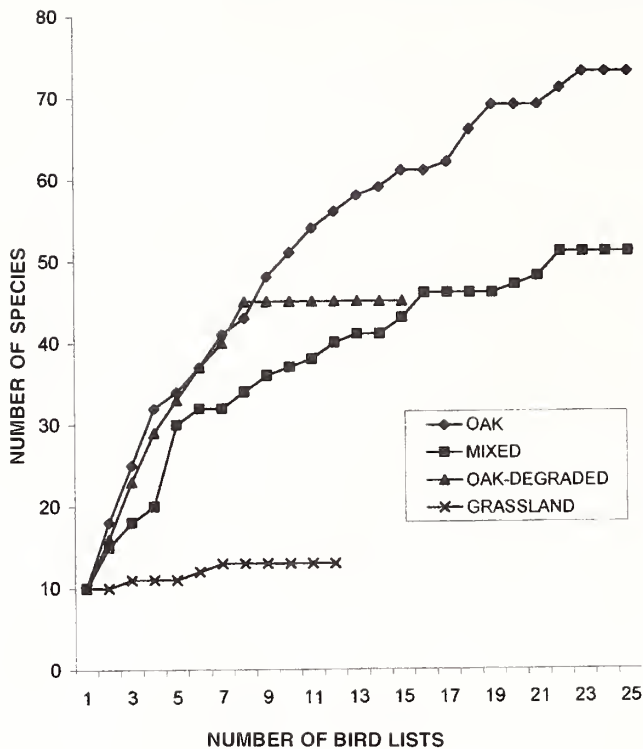


Fig. 2: Number of bird lists plotted against cumulative number of species during pre-monsoon season at Pindari Reserve Forest

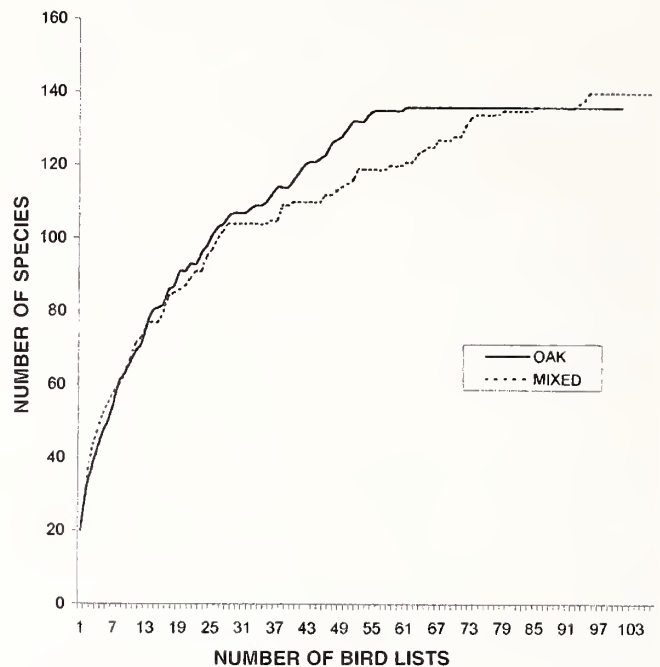


Fig. 4: Number of bird lists plotted against cumulative number of species during pre-monsoon season at Vinaiyak Reserve Forest

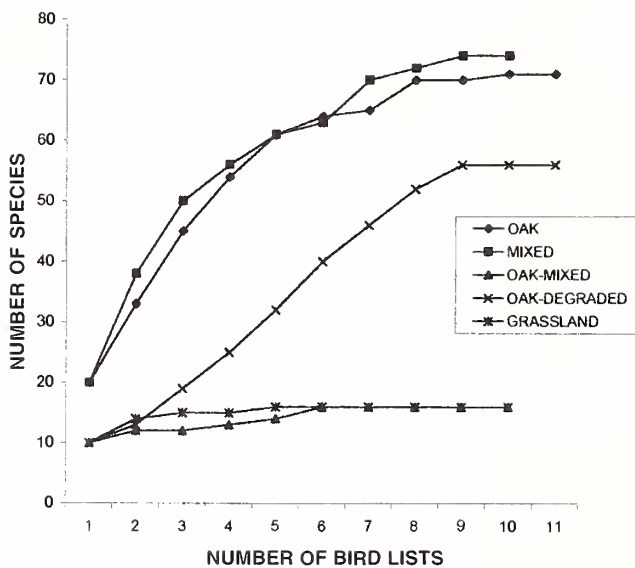


Fig. 3: Number of bird lists plotted against cumulative number of species during post-monsoon season at Pindari Reserve Forest

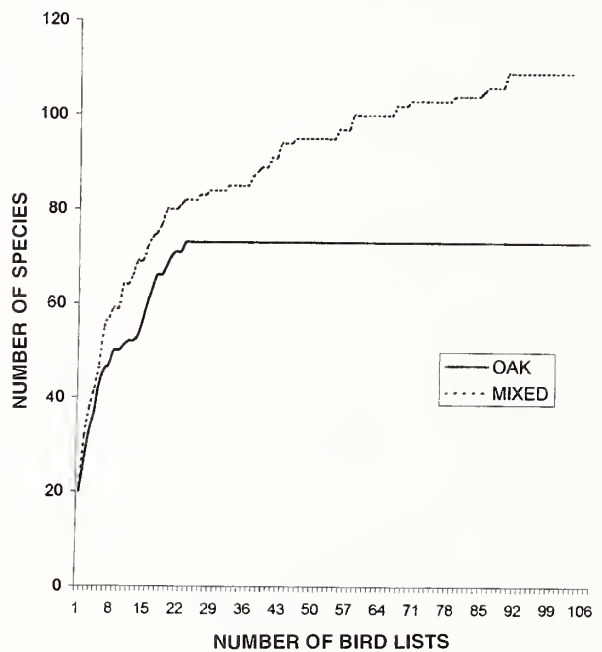


Fig. 5: Number of bird lists plotted against cumulative number of species during post-monsoon season at Vinaiyak Reserve Forest

Sorenson's similarity index showed greatest similarity (0.96) in terms of bird species in mixed and oak habitats of Pindari during post monsoon months, followed by mixed and oak-degraded habitats (0.76). During the pre-monsoon season, the maximum similarity (0.89) was observed between

oak and oak-degraded habitats, followed by oak and mixed habitats (0.53) (Tables 4 & 5).

Birds were also classified according to their status in Pindari and Vinaiyak (Table 6). Resident bird species predominated at both sites.

**Table 3:** Classification of birds (percentage of species) according to their guilds in Pindari Reserve Forest during pre-monsoon season 1998 and post-monsoon season 2000

Guilds	Oak	Mixed	Oak-deg	Oak-mix	Grl
<b>Pre-monsoon</b>					
Insectivore	52.6	60	51.1	-	33.3
Fruigivore	1.3	0	0	-	0
Carnivore	5.2	0	11.1	-	0
Grainivore	9.2	5	8.8	-	33.3
Omnivore	28.9	30	26.6	-	33.3
Nectarivore	2.6	5	2.2	-	0
<b>Post-monsoon</b>					
Insectivore	60.27	53.52	46.15	31.57	9.09
Fruigivore	2.7	1.40	5.76	10.52	9.09
Carnivore	8.21	14.08	7.69	15.78	27.27
Grainivore	8.2	9.85	15.38	0	9.09
Omnivore	20.54	21.12	25.0	42.10	45.45
Nectarivore	0	0	0	0	0

Oak-deg = Oak degraded, Grl = Grassland

Bird species diversity and richness were calculated for different habitat types of Vinaiyak and Pindari reserve forests as well as for different locations of Pindari (Tables 7 and 8). Diversity was greatest in oak habitat in Pindari during both seasons (BSD = 3.77 and 3.66), while in Vinaiyak it was greatest in oak habitat during pre-monsoon season (BSD = 3.99), but post monsoon it was high in mixed habitat (BSD = 3.54).

Bird species richness varied between habitats at both sites. It was highest in oak habitat (BSR = 11.57) during pre-monsoon season in Pindari, while highest in mixed habitat, during post-monsoon season. In Vinaiyak, BSR was greatest in mixed habitat in both seasons.

## DISCUSSION

The unequal sampling of birds in different habitat types does not allow rigorous treatment of differences in species richness of each site. Besides, this method does not allow any habitat quantification, so bird-habitat relationships were not explored. However, comparison of number of species sighted, species richness and diversity showed that these parameters do differ between habitats. For example, fewer bird lists in Pindari yielded relatively higher numbers of species compared to Vinaiyak.

Bird species diversity and richness were highest in oak habitat in Pindari, both pre- and post-monsoon. Oak provides a pristine and suitable habitat for many bird species. But bird species richness was also high in oak degraded habitat. Studies in the Western Ghats (Daniels *et al.* 1992) and in the Terai region (Javed 1996) have shown similar results. They

**Table 4:** Percentage similarity (Sorenson's Similarity Index) in bird species composition in different habitats of Pindari Reserve Forest during pre-monsoon season 1998

Habitats	Oak	Mixed	Oak-deg	Grl
Oak	100			
Mixed	53	100		
Oak-deg	89	41	100	
Grl	2	0	4	100

Oak-deg = Oak degraded, Grl = Grassland

**Table 5:** Percentage similarity (Sorenson's Similarity Index) in bird species composition in different habitats of Pindari Reserve Forest during post-monsoon season 2000

Habitats	Oak	Mixed	Oak-mix	Oak-deg	Grl
Oak	100				
Mixed	96	100			
Oak-mix	20	31	100		
Oak-deg	71	76	36	100	
Grl	18	26	21	10	100

Oak-deg = Oak degraded, Grl = Grassland

refuted the null hypothesis that bird diversity and density were least in disturbed habitats. Birds prefer relatively open areas for feeding and perching. In Vinaiyak, species diversity was highest in the oak habitat before monsoon and in the mixed habitat after monsoon. The majority of fruiting tree and shrub species, such as *Myrica esculenta*, *Rufus biflorous*, *Berberis aristata* and *Quercus* sp., occurred only in oak habitat. Insectivores dominated the oak habitat at both sites, but not grasslands of Pindari, where omnivores were more in number. Alpine grasslands are generally located at higher altitudes (>3,000 m) where only omnivores can survive.

The majority of species of pristine habitat are clearly adaptable to habitat degradation and occur in reasonable abundance in disturbed habitat. In Pindari, Alpine Swift *Tachymarptis melba*, Brown-fronted Pied Woodpecker *Dendrocopos auriceps*, Black-and-Yellow Grosbeak *Mycerobas icterioides*, Chestnut-bellied Nuthatch *Sitta castanea* and Grey-winged Blackbird *Turdus boulboul* were abundant in oak habitat. Red-billed Chough *Pyrrhocorax pyrrhocorax* and Yellow-billed Chough *Pyrrhocorax graculus* were found in grassland only, whereas Alpine Accentor *Prunella collaris*, Brown Bullfinch *Pyrrhula nipalensis*, Chestnut-bellied Rock-Thrush *Monticola rufiventris*, and Long-tailed Thrush *Zoothera dixonii* were found in mixed habitat only. These are large-bodied birds, which need open space to perch and feed. These species were also found in disturbed areas of their habitat in large numbers. Golden Bush-

**Table 6:** Classification of birds according to their status in Pindari and Vinaiyak Reserve Forests

Status	Pindari	Vinaiyak
Resident	132	139
Resident migratory	22	27
Migratory	9	8
Vagrant	1	

**Table 7:** Season-wise bird species diversity (BSD) and bird species richness (BSR) in different habitat types in Pindari Reserve Forest

Season	Oak	Oak-mix	Oak-deg	Mixed	Grl
Pre-monsoon BSD	3.77	-	2.98	2.57	1.69
BSR	11.57	-	7.31	4.69	1.66
Post-monsoon BSD	3.66	2.53	2.90	3.14	1.69
BSR	10.93	4.15	7.71	11.33	2.18

Oak-deg = Oak degraded, Grl = Grassland

**Table 8:** Season-wise bird species diversity (BSD) and bird species richness (BSR) in different habitat types in Vinaiyak Reserve Forest

Season		Oak	Mixed
Pre-monsoon	BSD	3.99	3.93
	BSR	15.96	16.94
Post-monsoon	BSD	3.51	3.54
	BSR	9.81	11.78

Robin *Tarsiger chrysaeus*, Little Pied Flycatcher *Ficedula westermanni*, Long-tailed Broadbill *Psarisomus dalhousiae*, Yellow-billed Blue Magpie *Urocissa flavirostris* and Emerald Dove *Chalcophaps indica* were oak habitat specific species in Vinaiyak, while White-cheeked Nuthatch *Sitta leucopsis*, Spotted Nutcracker *Nucifraga caryocatactes*, Eurasian Tree Pipit *Anthus trivialis*, Jungle Myna *Acridotheres fuscus* and Lesser-Racket tailed Drongo *Dicrurus remifer* were mixed coniferous specific birds.

In the Kumaon Himalaya, temperate forest includes mixed broad leaves, moist oak and rhododendron and dry coniferous forest of pines and firs. Higher up, sub-alpine forests of birch, rhododendron and juniper occur. The forests of this region are vitally important for many species. Several widespread endemic species such as Plum-headed parakeet *Psittacula cynocephala* are usually confined to tropical deciduous forest, but this species was sighted in temperate forest up to 2,300 m in Kumaon. Temperate forests support a high proportion of species with restricted distributions, notably the White-throated Tit *Aegithalos niveogularis*, which frequents bushes in mixed forest and dwarf shrub

berries near the tree line during the breeding season (Grimmett *et al.* 1998). This bird was frequently sighted in Pindari and Vinaiyak. Another Himalayan endemic Pied Thrush *Zoothera wardii*, which breeds in open broad-leaved forest, was seen twice in Pindari and once in Vinaiyak. BirdLife International (2000) has found that restricted range species tend to occur at sites, which are islands or isolated patches of a particular habitat. This is known as endemism, and such sites are often called Endemic Bird Areas or 'conservation hotspots'. Eight centres of endemism have been identified in the Indian subcontinent, and the Western Himalaya is among them (Grimmett *et al.* 1998). The 11 species endemic to the Western Himalaya include the probably extinct Himalayan Quail *Ophrysia superciliosa*, which was once distributed in Nainital region. Among other species, the Cheer pheasant *Catreus wallichii* thought to be at risk of extinction was sighted in Pindari and Vinaiyak. Another pheasant, Satyr Tragopan *Tragopan satyra* (near threatened) is also restricted to the western Kumaon Himalaya, but is not found in Garhwal Himalaya. All these species are threatened due to habitat loss and hunting.

There are only two wildlife sanctuaries in Kumaon, i.e. Askot Wildlife Sanctuary (Pithoragarh district, 600 sq. km) and Binsar Wildlife Sanctuary (Bageshwar district, 45.59 sq. km). The area protected (3.1%) is too small in comparison with the total geographical area (21,032 sq. km). Both sanctuaries face severe threats due to anthropogenic activities. Therefore, in order to conserve endemic bird species, pheasants, endangered mammals and plant species, more areas have to be brought under the protected area network.

We have in our earlier study (Hussain *et al.* 2000), recommended creation of two more sanctuaries (the present study sites), in Bageshwar district (Pindari forest complex) and in Nainital district (Kilbery-Vinaiyak-Kunjakharak forest complex), which would conserve the entire biodiversity. Blue prints for these proposed sanctuaries were prepared from the toposheet of Survey of India (Govt. of India). The Kilbery, Vinaiyak and Kunjakharak forest complex (proposed Naina Wildlife Sanctuary) and the forest patches of Dhakuri, Khati, Pindari and Sunderdunga (Pindari forest complex; proposed Pindari Wildlife Sanctuary) are contiguous and therefore of greater conservation value. Moreover, an extensive community awareness and education program should be carried out to familiarize locals with the importance of biodiversity in general and avian species in particular.

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BIRD COMMUNITIES OF THE PROPOSED NAINA AND PINDARI WILDLIFE SANCTUARIES

**Appendix:** List of birds sighted with presence / absence in different habitat types of Vinaiyak and Pindari Reserve Forests.

Ok-mx = Oak-mixed, Ok-deg = Oak- degraded, Grl = Grassland. (presence = +, absence = -)

Species	Altitude range	Vinaiyak		Pindari				
		Oak	Mixed	Oak	Mixed	Ok-mx	Ok-deg	Grl
Oriental Turtle Dove <i>Streptopelia orientalis</i>	1,200-2,500	+	+	+	+	-	+	-
Blue Rock Pigeon <i>Columba livia</i>	1,600	-	+	-	-	-	-	-
Emerald Dove <i>Chalcophaps indica</i>	1,600	+	-	-	-	-	-	-
Oriental Magpie-Robin <i>Copsychus saularis</i>	1,600	-	+	-	-	-	-	-
Common Stonechat <i>Saxicola torquata</i>	1,600	-	+	-	-	-	-	-
Black Francolin <i>Francolinus francolinus</i>	1,600-1,800	-	+	-	-	-	+	-
Indian Jungle Nightjar <i>Caprimulgus indicus</i>	1,600-2,300	+	+	-	-	-	-	-
Eurasian Sparrowhawk <i>Accipiter nisus</i>	1,600-2,700	+	+	+	+	-	+	+
Crested Bunting <i>Melophus lathami</i>	1,700-1,900	-	+	-	-	-	-	-
Plain Leaf-Warbler <i>Phylloscopus neglectus</i>	1,700-2,000	+	+	+	+	-	-	-
Large-tailed Nightjar <i>Caprimulgus macrurus</i>	1,700-2,200	+	+	-	-	-	-	-
Large Yellow-naped Woodpecker <i>Picus flavinucha</i>	1,700-2,400	-	+	-	-	-	-	-
Northern Goshawk <i>Accipiter gentilis</i>	1,700-2,400	+	+	-	+	+	+	+
Grey-headed Flycatcher <i>Culicicapa ceylonensis</i>	1,700-2,400	+	+	+	+	-	+	-
Ashy Drongo <i>Dicrurus leucophaeus</i>	1,700-2,600	+	+	+	-	-	-	-
Lesser Racket-tailed Drongo <i>Dicrurus remifer</i>	1,800	-	+	-	-	-	-	-
Spotted Dove <i>Streptopelia chinensis</i>	1,800-2,000	+	+	+	-	-	-	-
Little Pied Flycatcher <i>Ficedula westermanni</i>	1,800-2,000	+	+	-	-	-	-	-
Chestnut-bellied Nuthatch <i>Sitta castanea</i>	1,800-2,000	+	+	+	+	-	-	-
Great Tit <i>Parus major</i>	1,800-2,000	+	-	-	-	-	-	-
Red-vented Bulbul <i>Pycnonotus cafer</i>	1,800-2,000	+	+	-	-	-	-	-
Himalayan Pied Woodpecker <i>Dendrocopos himalayensis</i>	1,800-2,100	+	+	+	+	-	+	-
Scarlet Minivet <i>Pericrocotus flammeus</i>	1,800-2,100	+	+	-	-	-	-	-
Spangled Drongo <i>Dicrurus hottentottus</i>	1,800-2,100	+	+	-	-	-	-	-
Orange-gorgeted Flycatcher <i>Ficedula strophliata</i>	1,800-2,100	+	+	+	+	-	+	-
Brown Prinia <i>Prinia criniger</i>	1,800-2,100	+	-	-	-	-	-	-
Brown-fronted Pied woodpecker <i>Dendrocopos auriceps</i>	1,800-2,200	-	+	+	-	-	-	-
Common Hoopoe <i>Upupa epops</i>	1,800-2,200	+	-	-	-	-	+	-
Plum-headed Parakeet <i>Psittacula cyanocephala</i>	1,800-2,200	+	+	-	-	-	-	-
Red-billed Blue Magpie <i>Urocissa erythrorhyncha</i>	1,800-2,200	+	+	-	-	-	-	-
Dark-throated Thrush <i>Turdus ruficollis</i>	1,800-2,200	+	+	+	+	-	-	-
White-browed Bush-Robin <i>Tarsiger indicus</i>	1,800-2,200	+	+	-	-	-	-	-
Blue-fronted Redstart <i>Phoenicurus frontalis</i>	1,800-2,200	+	+	+	+	-	+	+
Common Myna <i>Acridotheres tristis</i>	1,800-2,200	+	+	-	-	+	+	-
Oriental White-eye <i>Zosterops palpebrosus</i>	1,800-2,200	+	+	+	+	-	-	+
Grey-faced Leaf-Warbler <i>Phylloscopus maculipennis</i>	1,800-2,200	+	+	+	+	-	-	-
Grey Wagtail <i>Motacilla cinerea</i>	1,800-2,200	+	+	-	-	-	-	-
Jungle Myna <i>Acridotheres fuscus</i>	1,800-2,300	-	+	-	-	-	-	-
Grey Treepie <i>Dendrocitta formosae</i>	1,800-2,300	+	+	-	-	-	-	-
Long-tailed Minivet <i>Pericrocotus ethologus</i>	1,800-2,300	+	+	+	+	-	+	-
Sooty Flycatcher <i>Muscicapa sibirica</i>	1,800-2,300	+	+	+	+	-	+	-
Blue-capped Redstart <i>Phoenicurus caeruleocephalus</i>	1,800-2,300	+	+	+	+	-	+	-
Spotted Forktail <i>Enicurus maculatus</i>	1,800-2,300	+	+	+	+	-	-	-
Fire-tailed Sunbird <i>Aethopyga ignicauda</i>	1,800-2,300	+	-	-	-	-	-	-
Oriental Tree Pipit <i>Anthus hodgsoni</i>	1,800-2,300	+	+	-	-	-	-	-
Rock Bunting <i>Emberiza cia</i>	1,800-2,300	-	-	+	+	-	+	-
Large Scaly-bellied Green Woodpecker <i>Picus squamatus</i>	1,800-2,400	+	-	-	-	-	-	-
Common Cuckoo <i>Cuculus canorus</i>	1,800-2,400	+	+	-	-	-	-	-
Slaty-headed Parakeet <i>Psittacula himalayana</i>	1,800-2,400	+	+	-	-	-	+	-
White-rumped Needletail-Swift <i>Zoonavena sylvatica</i>	1,800-2,400	-	+	-	-	-	-	-
Brown Wood-Owl <i>Strix leptogrammica</i>	1,800-2,400	+	+	-	-	-	-	-
Wedge-tailed Green-Pigeon <i>Treron sphenura</i>	1,800-2,400	+	+	-	-	-	-	-
Eurasian Collared-Dove <i>Streptopelia decaocto</i>	1,800-2,400	+	+	-	-	-	-	-

BIRD COMMUNITIES OF THE PROPOSED NAINA AND PINDARI WILDLIFE SANCTUARIES

**Appendix:** List of birds sighted with presence / absence in different habitat types of Vinaiyak and Pindari Reserve Forests.  
Ok-mx = Oak-mixed, Ok-deg = Oak- degraded, Grl = Grassland. (presence = +, absence = -) (contd.)

Species	Altitude range	Vinaiyak		Pindari				
		Oak	Mixed	Oak	Mixed	Ok-mx	Ok-deg	Grl
Common Kestrel <i>Falco tinnunculus</i>	1,800-2,400	-	-	+	+	-	+	+
Black-headed Jay <i>Garrulus lanceolatus</i>	1,800-2,400	+	+	-	-	-	-	-
Maroon Oriole <i>Oriolus trailii</i>	1,800-2,400	+	+	+	-	-	-	-
Blue-headed Rock-Thrush <i>Monticola cinclorhynchus</i>	1,800-2,400	+	+	-	-	-	-	-
Rufous-bellied Niltava <i>Niltava sundara</i>	1,800-2,400	+	+	-	+	+	+	-
Grey Bushchat <i>Saxicola ferrea</i>	1,800-2,400	+	+	+	-	-	+	-
Eurasian Tree-Creeper <i>Certhia familiaris</i>	1,800-2,400	+	+	+	+	-	+	-
Common Swallow <i>Hirundo rustica</i>	1,800-2,400	+	+	-	-	-	-	-
Blyth's Leaf-Warbler <i>Phylloscopus reguloides</i>	1,800-2,400	+	+	+	+	-	+	-
Common Rosefinch <i>Carpodacus erythrinus</i>	1,800-2,400	+	+	-	-	-	-	-
Collared Owlet <i>Glaucidium brodiei</i>	1,800-2,500	+	+	+	-	-	-	-
Black-naped Green Woodpecker <i>Picus canus</i>	1,800-2,500	-	-	+	+	-	+	-
Kaleej Pheasant <i>Lophura leucomelanos</i>	1,800-2,500	+	+	+	+	+	+	-
Black Eagle <i>Ictinaetus malayensis</i>	1,800-2,500	+	+	+	+	-	+	-
Eurasian Jay <i>Garrulus glandarius</i>	1,800-2,500	+	+	+	-	-	+	-
Verditer Flycatcher <i>Eumyias thalassina</i>	1,800-2,500	+	+	-	-	-	-	-
White-capped Redstart <i>Chaimarrornis leucocephalus</i>	1,800-2,500	+	+	+	+	+	+	-
Green-backed Tit <i>Parus monticolus</i>	1,800-2,500	+	+	+	+	-	+	-
Red-headed Tit <i>Aegithalos concinnus</i>	1,800-2,500	+	+	+	+	-	+	-
Black Bulbul <i>Hypsipetes leucocephalus</i>	1,800-2,500	+	+	-	-	-	-	-
Streaked Laughingthrush <i>Garrulax lineatus</i>	1,800-2,500	+	+	+	-	+	+	-
Rusty-cheeked Scimitar-Babbler <i>Pomatorhinus erythrogenys</i>	1,800-2,500	+	+	-	-	-	-	-
Bar-tailed Tree-Creeper <i>Certhia himalayana</i>	1,800-2,600	+	+	+	+	-	+	-
Koklass Pheasant <i>Pucrasia macrolopha</i>	1,800-2,600	+	+	+	+	-	+	-
Great Barbet <i>Megalaima virens</i>	1,800-2,600	+	+	+	-	-	+	-
Ultramarine Flycatcher <i>Ficedula superciliaris</i>	1,800-2,600	+	+	+	-	-	-	-
Black-lored Yellow Tit <i>Parus xanthogenys</i>	1,800-2,600	+	+	+	-	-	-	-
Himalayan Bulbul <i>Pycnonotus leucogenys</i>	1,800-2,600	+	+	+	-	-	-	-
Grey-headed Flycatcher-Warbler <i>Seicercus xanthoschistos</i>	1,800-2,600	+	+	+	+	-	+	-
White-throated Laughingthrush <i>Garrulax albogularis</i>	1,800-2,600	+	+	+	+	+	+	-
Rufous Sibia <i>Heterophasia capistrata</i>	1,800-2,600	+	+	+	+	-	+	-
Striated Laughingthrush <i>Garrulax striatus</i>	1,800-2,700	+	+	+	+	+	+	-
Blue Whistling-Thrush <i>Myiophonus caeruleus</i>	1,800-2,700	+	+	+	+	+	+	-
Jungle Crow <i>Corvus macrorhynchos</i>	1,800-2,800	+	+	+	+	+	+	+
Bearded Vulture <i>Gypaetus barbatus</i>	1,800-3,000	+	+	+	+	+	+	-
Himalyan Griffon <i>Gyps himalayensis</i>	1,800-3,000	+	+	+	+	+	+	-
Pacific Swift <i>Apus pacificus</i>	1,900	+	+	-	-	-	-	-
Spotted Owlet <i>Athene brama</i>	1,900	-	+	-	+	-	-	-
Eurasian Tree Sparrow <i>Passer montanus</i>	1,900-2,200	+	+	+	-	-	+	-
Indian Cuckoo <i>Cuculus micropterus</i>	1,900-2,400	+	+	-	-	-	-	-
Mistle Thrush <i>Turdus viscivorus</i>	1,900-2,400	+	+	+	-	-	-	-
Gold-spectacled Flycatcher-Warbler <i>Seicercus burkii</i>	1,900-2,400	+	+	+	-	-	-	-
Greater Scaly-breasted Wren-Babbler <i>Pnoepyga albiventer</i>	1,900-2,400	+	-	-	-	-	-	-
Black-faced Flycatcher-Warbler <i>Abroscopus schisticeps</i>	1,900-2,500	-	-	+	-	-	-	-
Alpine Swift <i>Tachymarpis melba</i>	1,900-2,600	+	+	+	-	-	-	-
Yellow-naped Yuhina <i>Yuhina flavicollis</i>	1,900-2,700	+	+	+	+	-	-	-
Brown Hawk-Owl <i>Ninox scutulata</i>	2,000	+	+	-	-	-	-	-
Rufous-bellied Bulbul <i>Hypsipetes mccllelandi</i>	2,000	+	+	-	-	-	-	-
White-crested Laughingthrush <i>Garrulax leucolophus</i>	2,000	-	+	-	-	-	-	-
Red-headed Vulture <i>Sarcogyps calvus</i>	2,000-2,200	-	+	-	-	-	-	-
Bonelli's Eagle <i>Hieraaetus fasciatus</i>	2,000-2,300	-	+	-	-	-	-	-
Red-winged Shrike Babbler <i>Pteruthius flaviscapis</i>	2,000-2,300	+	+	+	-	-	-	-
Common Hill-Partridge <i>Arborophila torqueola</i>	2,000-2,400	+	+	+	-	-	-	-



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**Appendix:** List of birds sighted with presence / absence in different habitat types of Vinaiyak and Pindari Reserve Forests.  
Ok-mx = Oak-mixed, Ok-deg = Oak- degraded, Grl = Grassland. (presence = +, absence = -) (contd.)

Species	Altitude range	Vinaiyak		Pindari				
		Oak	Mixed	Oak	Mixed	Ok-mx	Ok-deg	Grl
Orange-flanked Bush-Robin <i>Tarsiger cyanurus</i>	2,000-2,400	+	+	+	+	-	+	-
Grey-headed Bunting <i>Emberiza fucata</i>	2,000-2,400	+	+	+	+	-	+	+
Large Hawk-Cuckoo <i>Hierococcyx sparveroides</i>	2,000-2,500	+	+	-	-	-	-	-
White-browed Tit-Babbler <i>Alcippe vinipectus</i>	2,000-2,500	-	-	+	+	-	+	+
Green-tailed Sunbird <i>Aethopyga nipalensis</i>	2,000-2,500	+	+	-	-	-	-	-
White-throated Needletail-Swift <i>Hirundapus caudacutus</i>	2,000-2,600	+	+	-	-	-	-	-
Snow Pigeon <i>Columba leuconota</i>	2,000-2,600	-	-	+	+	+	+	+
White-throated Tit <i>Aegithalos niveogularis</i>	2,000-2,600	+	+	+	-	-	-	-
Western Crowned Warbler <i>Phylloscopus occipitalis</i>	2,000-2,600	+	+	+	-	-	-	-
Eurasian Skylark <i>Alauda arvensis</i>	2,100	+	+	-	-	-	-	-
Indian Treepie <i>Dendrocitta vagabunda</i>	2,100	-	-	-	-	-	+	-
Pied Flycatcher-Shrike <i>Hemipus picatus</i>	2,100	-	+	-	-	-	-	-
Short-billed Minivet <i>Pericrocotus brevirostris</i>	2,100	+	+	-	-	-	-	-
Chestnut Thrush <i>Turdus rubrocanus</i>	2,100	-	+	-	-	-	-	-
Nepal House-Martin <i>Delichon nipalensis</i>	2,100	+	+	+	-	-	-	-
Common Lesser Whitethroat <i>Sylvia curruca</i>	2,100	-	+	-	+	-	+	-
Spotted Munia <i>Lonchura punctulata</i>	2,100	-	+	-	-	-	-	-
Grey-backed Shrike <i>Lanius tephronotus</i>	2,100-2,200	-	+	-	-	-	-	-
Black-throated Sunbird <i>Aethopyga saturata</i>	2,100-2,200	+	+	-	-	-	-	-
Long-tailed Thrush <i>Zoothera dixonii</i>	2,100-2,300	+	+	-	+	-	-	-
Small Niltava <i>Niltava macgrigoriae</i>	2,100-2,300	-	+	-	-	-	-	-
Spotted Bush-Warbler <i>Bradypterus thoracicus</i>	2,100-2,300	-	+	-	-	-	-	-
Greenish Leaf-Warbler <i>Phylloscopus trochiloides</i>	2,100-2,300	-	+	+	-	-	-	-
Blue-winged Minla <i>Minla cyanouroptera</i>	2,100-2,300	+	+	-	-	-	-	-
Vinaceous Rosefinch <i>Carpodacus vinaceus</i>	2,100-2,300	-	-	-	-	-	-	+
Scaly Thrush <i>Zoothera dauma</i>	2,100-2,400	+	+	-	-	-	-	-
Black-winged Cuckoo-Shrike <i>Coracina melaschistos</i>	2,100-2,400	-	-	-	-	-	+	-
Winter Wren <i>Troglodytes troglodytes</i>	2,100-2,400	-	+	+	+	-	-	-
Rufous-bellied Crested Tit <i>Parus rubidiventris</i>	2,100-2,400	-	-	-	+	-	-	-
Hume's Warbler <i>Phylloscopus humei</i>	2,100-2,400	-	-	+	+	-	+	-
Pink-browed Rosefinch <i>Carpodacus rodochrous</i>	2,100-2,400	+	-	-	-	-	+	-
Yellow-bellied Fantail-Flycatcher <i>Rhipidura hypoxantha</i>	2,100-2,500	+	+	-	-	+	-	-
Brown Dipper <i>Cinclus pallasii</i>	2,100-2,500	-	-	+	+	-	+	-
Chestnut-bellied Rock-Thrush <i>Monticola rufiventris</i>	2,100-2,500	+	+	+	+	-	+	-
Fire-capped Tit <i>Cephalopyrus flammiceps</i>	2,100-2,500	-	-	+	-	-	-	-
Bar-throated Minla <i>Minla strigula</i>	2,100-2,500	+	+	-	-	-	-	-
Fire-breasted Flowerpecker <i>Dicaeum ignipectus</i>	2,100-2,500	+	-	-	-	-	-	-
Yellow-breasted Greenfinch <i>Carduelis spinoides</i>	2,100-2,500	+	+	+	+	-	+	-
Yellow-billed Blue Magpie <i>Urocissa flavirostris</i>	2,100-2,600	+	-	+	+	-	+	-
Grey-winged Blackbird <i>Turdus boulboul</i>	2,100-2,600	+	+	+	-	-	-	-
Plumbeous Redstart <i>Rhyacornis fuliginosus</i>	2,100-2,600	-	+	+	+	-	+	-
Little Forktail <i>Enicurus scouleri</i>	2,100-2,600	+	+	-	-	-	-	-
White-tailed Nuthatch <i>Sitta himalayensis</i>	2,100-2,600	+	+	+	+	-	+	-
Tickell's Warbler <i>Phylloscopus affinis</i>	2,100-2,600	+	+	-	+	-	+	-
Stripe-throated Yuhina <i>Yuhina gularis</i>	2,100-2,600	+	+	+	+	-	+	-
Mrs. Gould's Sunbird <i>Aethopyga gouldiae</i>	2,100-2,600	-	-	+	-	-	-	-
Rufous-bellied Pied Woodpecker <i>Dendrocopos hyperythrus</i>	2,100-2,700	-	-	+	+	-	-	-
Spot-winged Crested Tit <i>Parus melanolophus</i>	2,100-2,700	+	+	+	+	-	+	-
Black-and-Yellow Grosbeak <i>Mycerobas icterioides</i>	2,100-2,700	+	+	+	+	-	-	-
Red-headed Trogon <i>Harpactes erythrocephalus</i>	2,200	+	-	-	-	-	-	-
Shikra <i>Accipiter badius</i>	2,200	-	-	+	+	-	+	+
Mountain Hawk-Eagle <i>Spizaetus nipalensis</i>	2,200	-	+	-	-	-	-	-
Large Cuckoo-Shrike <i>Coracina macei</i>	2,200	-	+	-	-	-	-	-

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**Appendix:** List of birds sighted with presence / absence in different habitat types of Vinaiyak and Pindari Reserve Forests.

Ok-mx = Oak-mixed, Ok-deg = Oak- degraded, Grl = Grassland. (presence = +, absence = -) (contd.)

Species	Altitude range	Vinaiyak		Pindari				
		Oak	Mixed	Oak	Mixed	Ok-mx	Ok-deg	Grl
White-browed Fantail-Flycatcher <i>Rhipidura aureola</i>	2,200	+	-	-	-	-	-	-
Pied Thrush <i>Zoothera wardii</i>	2,200	-	+	-	-	-	-	-
Greater Long-billed Thrush <i>Zoothera monticola</i>	2,200	+	+	-	-	-	-	-
Indian Blue Robin <i>Luscinia brunnea</i>	2,200	-	+	-	-	-	-	-
Eurasian Nuthatch <i>Sitta europaea</i>	2,200-2,400	-	+	-	-	-	-	-
Tickell's Thrush <i>Turdus unicolor</i>	2,200-2,400	+	+	-	-	-	-	-
Brown Bullfinch <i>Pyrrhula nipalensis</i>	2,200-2,500	-	-	-	+	-	-	-
Coal Tit <i>Parus ater</i>	2,200-2,600	+	+	+	+	-	-	-
Brown Crested Tit <i>Parus dichrous</i>	2,200-2,600	-	-	+	+	-	-	-
Simla Crested Tit <i>Parus rufonuchalis</i>	2,200-2,700	+	+	+	+	-	-	-
Variegated Laughingthrush <i>Garrulax variegatus</i>	2,200-2,700	+	+	+	+	-	+	-
Red-breasted Parakeet <i>Psittacula alexandri</i>	2,300	-	+	-	-	-	-	-
Orange-bellied Chloropsis <i>Chloropsis hardwickii</i>	2,300	-	+	-	-	-	-	-
Plain-backed Thrush <i>Zoothera mollissima</i>	2,300	+	+	+	-	-	-	-
Golden Bush-Robin <i>Tarsiger chrysaeus</i>	2,300	+	-	-	-	-	-	-
Goldcrest <i>Regulus regulus</i>	2,300	+	+	-	-	-	-	-
Black-crested Bulbul <i>Pycnonotus melanicterus</i>	2,300	-	+	-	-	-	-	-
Chestnut-headed Tesia <i>Tesia castaneocoronata</i>	2,300	-	-	-	+	-	-	-
Hodgson's Mountain-Finch <i>Leucosticte nemoricola</i>	2,300	+	+	-	+	-	+	-
White-cheeked Nuthatch <i>Sitta leucopsis</i>	2,300-2,400	+	+	-	+	-	-	-
Yellow-browed Warbler <i>Phylloscopus inornatus</i>	2,300-2,500	+	+	+	+	-	-	-
Spot-winged Rosefinch <i>Carpodacus rodopeplus</i>	2,300-2,500	-	-	-	-	-	-	+
Red-headed Laughingthrush <i>Garrulax erythrocephalus</i>	2,300-2,600	+	+	+	+	+	+	-
White-collared Blackbird <i>Turdus albocinctus</i>	2,300-2,800	+	-	+	+	-	-	-
Long-tailed Broadbill <i>Psarisomus dalhousiae</i>	2,400	+	+	-	-	-	-	-
Tawny Pipit <i>Anthus campestris</i>	2,400	-	+	+	+	-	-	-
Hill Pigeon <i>Columba rupestris</i>	2,400-2,700	-	-	+	-	-	+	-
Rusty-tailed Flycatcher <i>Muscicapa ruficauda</i>	2,500	-	-	+	+	-	-	-
Slaty-blue Flycatcher <i>Ficedula tricolor</i>	2,500	-	-	-	-	-	+	-
Black-browed Leaf-Warbler <i>Phylloscopus cantator</i>	2,500	-	-	+	+	-	-	-
Eurasian Tree Pipit <i>Anthus trivialis</i>	2,500	-	+	-	-	-	-	-
Collared Grosbeak <i>Mycerobas affinis</i>	2,500	+	-	-	-	-	-	-
Wallcreeper <i>Tichodroma muraria</i>	2,600	-	-	-	-	+	-	-
Alpine Accentor <i>Prunella collaris</i>	2,600	-	-	+	+	-	-	-
Impeyan Monal <i>Lophophorus impejanus</i>	2,600-3,200	-	-	+	+	-	+	+
Spotted Nutcracker <i>Nucifraga caryocatactes</i>	2,800	-	+	-	-	-	-	-
Long-billed Bush-Warbler <i>Bradypterus major</i>	2,800	-	-	-	-	-	+	-
Red-headed Bullfinch <i>Pyrrhula erythrocephala</i>	2,800-3,000	-	-	+	+	-	-	-
Satyr Tragopan <i>Tragopan satyra</i>	2,800-3,100	-	-	+	+	-	-	-
Eurasian Woodcock <i>Scolopax rusticola</i>	3,000-4,000	-	-	-	-	-	-	+
Tibetan Partridge <i>Perdix hodgsoniae</i>	3,500-4,200	-	-	-	+	-	-	+
Red-billed Chough <i>Pyrrhocorax pyrrhocorax</i>	3,600	-	-	+	+	-	-	+
Yellow-billed Chough <i>Pyrrhocorax graculus</i>	3,600	-	-	-	-	-	-	+

■ ■ ■

# SEASONAL PATTERN IN THE TERRITORIAL DYNAMICS OF THE ARBOREAL ANT *OECOPHYLLA SMARAGDINA* (HYMENOPTERA: FORMICIDAE)<sup>1</sup>

N. RASTOGI<sup>2</sup>

<sup>1</sup>Accepted April 28, 2005

<sup>2</sup>Department of Zoology, Centre of Advanced Study, Banaras Hindu University, Varanasi 221 005, Uttar Pradesh, India.

Email: neelkamalrastogi@yahoo.co.in

A 30-month field study on territorial dynamics of *Oecophylla smaragdina* (Fabricius) (Hymenoptera: Formicidae) colonies in Varanasi, India, revealed a regular seasonal pattern in territorial organisation. Each colony exhibited a circannual rhythm pertaining to the size of the central territory (nesting trees) and the secondary territory (ground area). Incorporation of new nesting trees in the central territory showed a major peak in September and a smaller peak during March-April. In each colony, only one tree, located near the centre of the territory, was used continuously for a maximum duration (28 and 30 months in colony I and II respectively). In both the colonies, trees located at a distant from the centre of the colony territory were found to be incorporated in the central territory, during March-April and/or September each year. Ground area used by each colony was largest during September. The circannual rhythm of territorial organization may be related to the brood development and food requirements of the *Oecophylla smaragdina* colony. Thus, territorial expansion during September, each year, may be a fine-tuned evolutionary adaptation of the growing colony to the availability of insect prey during the southwest monsoon rains.

**Key words:** Arboreal ant, *Oecophylla smaragdina*, territorial dynamics, circannual rhythm, polydomous nest organization

## INTRODUCTION

Territorial behaviour is shown by a number of ant species (Hölldobler and Wilson 1990). Territorial ant species with polydomous nest organization (several nests belonging to the same colony) are able to patrol and exploit large areas of their territory simultaneously, without incurring the costs of transporting prey from distant points of capture to a single central nest (e.g. in *Camponotus gigas*, Pfeiffer and Linsenmair 2000). A seasonal, spatio-temporal variation in the location and density of nests has been reported in the polydomous ant species *Myrmecaria opaciventris* colonies (Kenne and Déjean 1999). However, so far, no investigation has focused on the annual, seasonal pattern in the territory size of a polydomous, tropical ant species maintaining absolute, three-dimensional territories.

The arboreal ant *Oecophylla smaragdina* (Fabricius) makes a silk-lined nest of living leaves (Hingston 1927), and is strongly territorial (Hölldobler 1983). The worker ants patrol three-dimensional territories comprising the central territory consisting of the tree(s) used for nesting and the secondary territory, the ground (Déjean 1990). Colonies of *O. smaragdina* (from Asia and Australia) and its closely related species *O. longinoda* (from Africa) have polydomous nest organization, with a large number of leaf nests scattered over canopies of several trees, within the territory. Individual colonies may cover an area of up to 1,600 sq. m and comprise of about a million workers and brood (Way 1954; Hölldobler 1979). Information regarding the territorial dynamics of *O. smaragdina* colonies is of particular ecological interest

and of economic significance, as *O. smaragdina* is the earliest known example of a biological control agent (Huang and Yang 1987) and is still used in China against citrus pests (Yang 1982). Both species of *Oecophylla* have been found to significantly reduce the number of a variety of insect pests of tropical crops, including Coconut *Cocos nucifera* (Vanderplank 1960), Cocoa *Theobroma cacao* (Room 1975) Mango *Mangifera indica* (Way 1954) and Coffee *Coffea arabica* (Leela 1961). In the present investigation, the territorial dynamics of *O. smaragdina* colonies have been studied for two and a half years, to examine the seasonal, annual pattern in the size of the central and secondary territories.

## STUDY AREA AND METHODOLOGY

This is part of a long-term field study carried out from July 1997 to December 1999 in the grounds of Banaras Hindu University Campus in Varanasi over an area of about 3,000 sq. m. The trees/shrubs occupied by *O. smaragdina* included *Mangifera indica* (Anacardiaceae), *Spondias pinnata* (Anacardiaceae); *Terminalia bellerica* (Combretaceae), *T. arjuna* (Combretaceae); *Psidium jambolana*, *P. guajava* (Myrtaceae); *Embllica officinalis* (Euphorbiaceae); *Mimusops elengi*, *Madhuka indica* (Sapotaceae); *Erwatamia* sp., *Nerium indicum* (Apocynaceae); and *Hibiscus rosa-sinensis* (Malvaceae). The trees being about 25 years old were tall (c. 12-15 m) with dense canopy. Many of the nests were high up in the upper part of the canopy while others were in the peripheral parts of the canopy. While some of the peripheral nests were clearly seen, it was



difficult to detect and count all the nests of *O. smaragdina* on each tree.

In the study area, *O. smaragdina* colonies were demarcated by experimental, forcible confrontation of marked workers (by using quick drying paints) to conspecifics present at the base of other tree trunks (Hölldobler 1983). The resident ants, on discovering intruders belonging to alien colonies, lunged at them, bit and pulled their appendages singly or in groups till all the intruders were killed. Thereafter, the residents moved up the tree trunks carrying the killed intruder ants, to their nests. Introduction of marked workers at the base of the parent tree trunk/on the ground area used by ants of the same colony, elicited simple antennation by the residents after which the introduced ant mingled with the residents and went up the tree trunks. The confrontation experiments were repeated five times, between conspecifics nesting on two different trees each time, using ten marked ants each, with five as control and five as experimental. Similarly, the foraging areas used by ants belonging to different colonies were demarcated. In this way, five colonies of *Oecophylla smaragdina* were distinguished in the field. However, two colonies were displaced by two different ant species; *Tetraponera allaborans* Walker and *Paratrechina longicornis* (Latr.) in August-September 1998, while the third colony, after three nest relocations in 1997 and one in 1998, could not be traced further in the field. Therefore, the seasonal changes in the territory size could be recorded continuously for 30 months only for territories of two colonies designated as colony I and II.

The number of trees/shrubs used by *O. smaragdina* workers for nesting and/or descending to the ground level for foraging/patrolling was recorded four times each month except during June each year. The presence/absence of nests was also recorded on the trees/shrubs during these observations, each month.

The ground area was marked into grids (each quadrant = 1 sq. m). Each quadrant was scanned (this involved walking the ground and taking observations for c. 3-4 hours per day, twice a week, during the study period; total c. 768 hours during 36 months) for the presence/absence of the foragers during the peak morning foraging hours (from 0800 to 1200 hrs). The data was recorded on a grid map four times a month for each colony from July 1997 to November 1999, except during June, December, January and February (the peak summer and winter seasons) when foraging activity was found to be reduced. The worker ants showed no foraging activity on cloudy days with maximum day temperature of 19°C during winter season. Observation of the leaf nests indicated that the foragers did not leave the nests. Data is given as mean  $\pm$  S.E.M. Results were statistically analysed using Student's *t* test.

The centre of the ground area patrolled by workers of each colony was determined by finding the values of the X and Y co-ordinates at 164 different points along the boundary of the territory of colony I and at 150 different points along the boundary of the territory of colony II.

## RESULTS

**Seasonal variation in the number of nesting trees used (central territory):** The number of nesting trees/shrubs used by a colony at a time varied from 2 to 8 ( $4.83 \pm 0.0163$ ) for colony I and 1 to 7 ( $2.76 \pm 0.011$ ) for colony II. The number of trees used by workers of each colony to descend to the ground to forage showed one small peak in March-April and a main

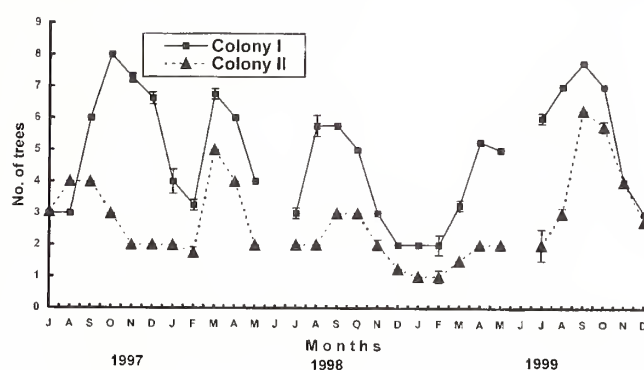


Fig. 1: Number of trees used (Mean  $\pm$  S.E.M.) for nesting and/or descending to ground level by workers of *O. smaragdina* colony I and colony II during various months from July 1997-December 1999

peak in September/September-October each year (Fig. 1). The number of nesting trees used during April differed significantly as compared to January, February and May ( $df=14$ ,  $p<0.001$  for colony I and  $p<0.005$  for colony II for each month), but was not significantly different with respect to March. ( $df=14$ ,  $p>0.5$ ). The number of nesting trees used during September was significantly higher with respect to July, August, November and December ( $df=22$ ,  $p<0.001$  and  $p<0.05$ ,  $p<0.005$  and  $p<0.01$  for colony I and  $df=99$ ,  $p<0.001$ ,  $p<0.05$ ,  $p<0.005$ ,  $p<0.001$  for colony II respectively). It did not differ significantly with respect to October ( $df=22$ ,  $p>0.5$ ). With the onset of summer (May) and winter (December-February) number of trees used by each colony decreased sharply each year (Fig. 1). Seventeen trees and nine shrubs were used in total, at various times by colony I and II foragers respectively.

**Duration of use for each tree:** Duration for which each tree was used for nesting varied from 1 to 28 ( $5.92 \pm 1.32$ ) months and 1 to 30 ( $9.15 \pm 2.14$ ) months for colony I and colony II, respectively (Figs 2a, 2b). Tree 'G' and tree 'c' were found to be used continuously for a maximum duration of 28 and 30

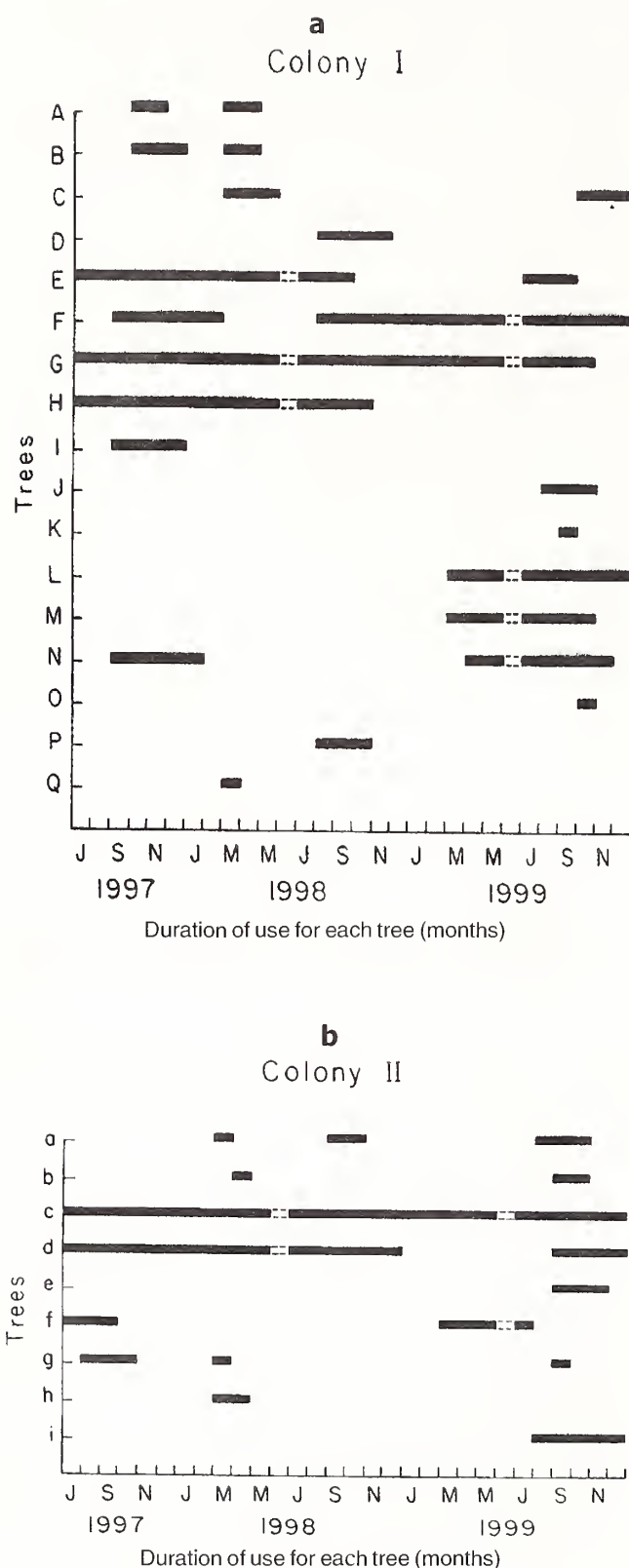


Fig. 2 a & b: Time duration of use (in months) of the trees/shrubs used for nesting/ descending to the ground for foraging in each colony (a) colony I (b) colony II, from July 1997 to December 1999

months in colony I and II, respectively and were found to occupy an approximate central location in the territory patrolled by the colony (Figs 3a, 3b). The canopy of tree 'G' was found to be in contact with those of trees/shrubs B, C, D, E, F, H, I, J, N, and P, either directly or indirectly. In colony II, canopy of tree 'c' was found to be in direct or indirect contact with the canopies of trees/shrubs of a, b, d, e, f, g and h.

In colony I, trees E, F, G, H, L, M, N were used for long periods ( $5-28$  months,  $11.4 \pm 0.792$ ) and in colony II, trees 'c' and 'd' were used for long periods ( $4-30$  months,  $17.33 \pm 5.31$ ). They were found to have some common features, tall and dense canopy, location close to the centre of the ground territory and direct canopy contact with tree 'G'/'c'. Trees with small, sparse canopy (J, K) or distantly located from the centre, and/or in indirect (or without) canopy contact with tree 'G' (trees A, B, C, D, O, P, and Q in colony I) or tree 'c' (trees a, b, e, f, g, h and i in colony II) were incorporated in the central territory only in March-April and/or September.

**Seasonal variation in the ground (secondary) territory used:** Ground territory patrolled and defended at a particular time by workers of colony I varied from 61 to 540 sq. m ( $217 \pm 0.92$ ), and that of colony II ranged from 38 to 295 sq. m ( $106.45 \pm 0.68$ ). The ground area defended by an *O. smaragdina* colony was found to increase rapidly from July to September each year, in each of the colonies (Figs 4a, 4b). In both, the ground area patrolled during September was significantly larger with respect to March, April and May ( $df=18$ ,  $p<0.005$ ,  $p<0.001$ ,  $p<0.005$  in colony I and  $p<0.001$ ,  $p<0.005$ ,  $p<0.001$  in colony II, respectively). It was also significantly larger as compared to July, August, October and November ( $df=22$ ,  $p<0.001$ ,  $p<0.05$ ,  $p<0.001$  in colony I and  $p<0.001$ ,  $p<0.005$ ,  $p<0.05$ ,  $p<0.001$  in colony II, respectively).

## DISCUSSION

The present study clearly shows that the central and secondary territory used by each *O. smaragdina* colony show an annual, seasonal variation in size. Recently, Wuellner and Saunders (2003) found circannual patterns of activity in *Solenopsis geminata* (F.) and *S. invicta* Buren workers. While the former showed no activity, the latter showed reduced activity above the ground during the coldest months, November through February.

This long-term investigation reveals that *O. smaragdina* exhibits a circannual rhythm in the number of trees (central territory) used by the foragers of a colony to descend to the ground level and in the size of the ground area (secondary territory), patrolled and foraged. Incorporation of new nesting trees showed a small peak during March-April and main peak during September each year, in each colony. On the other

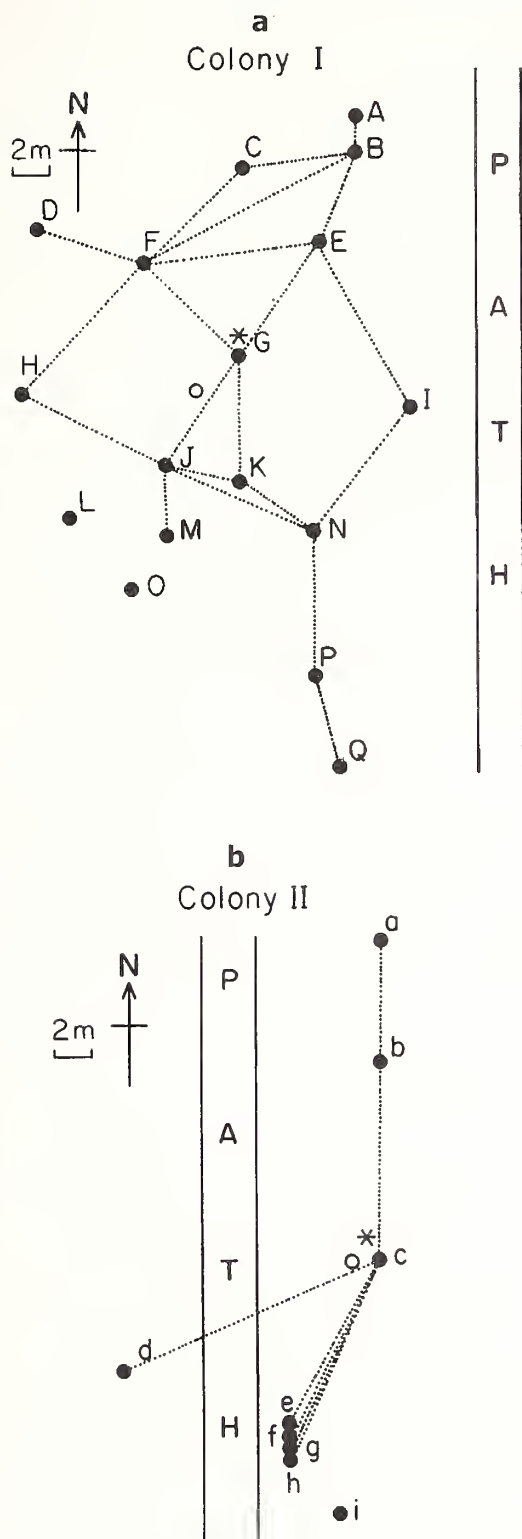


Fig. 3 a & b: Canopy contacts between trees/shrubs used for nesting by (a) ants of colony I and (b) ants of colony II. Asterisks denote the tree 'G' with central location used for maximum duration of 28 months in colony I and tree 'c' with central location in colony II and used for maximum duration of 30 months. Open circle denotes the center of each territory and closed circles denote the location of nesting trees/shrubs in territory of each colony

hand, the largest ground area was patrolled only during September each year. I suggest that the increase in the size of the ground territory, beginning in July and reaching a peak value in September, is probably correlated to the increase in the food requirements of the colony, which may be an adaptation to the availability of insect prey during the rainy season. In the northern plains of India, including Varanasi, the southwest monsoon retreats by the end-September so that rainfall ceases by October (Srivastava 2001). During October, the territory size decreases rapidly (Figs 4a, 4b). Thus, rainfall (along with temperature conditions) may be an important abiotic factor influencing territory size, though the basic territory size regulating factor is suggested to be the food requirements of the developing colony. On the basis of the present data it is difficult to explain the gradual decline in

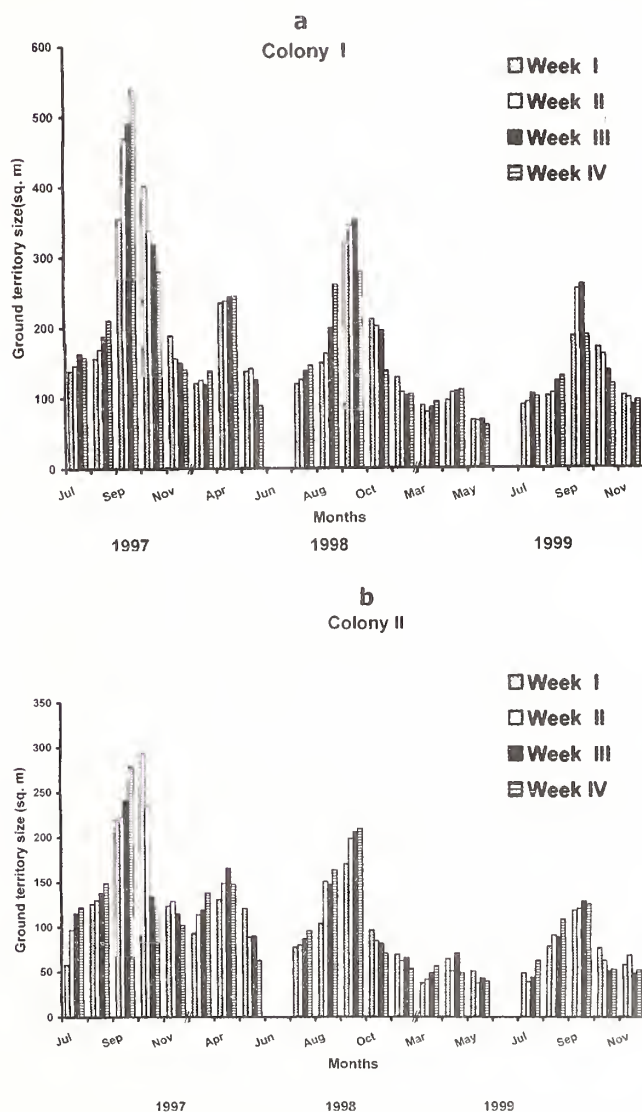


Fig. 4 a & b: Ground territory size of *O. smaragdina* (a) colony I and (b) colony II during each week, in different months, during three years: July-November 1997, from March-November 1998 & 1999



the peak value for the ground territory patrolled, from 1997 to 1999 in both colonies.

Seasonal variation in nest density, with density being higher during the rainy season, as compared to the dry season, and characterized by the disappearance of many nests at the end of the main rainy season, has also been reported in the polydomous colonies of *Myrmicaria opaciventris* Emery (Kenne and Déjean 1999). They have also recorded the exploitation of vast distant areas by means of underground tunnels in this polydomous ant species. Thus, polydomous nest organization, whether on the ground or on the tree canopy, facilitates efficient foraging over large areas during the favourable season. I suggest that *O. smaragdina* colonies initiate expansion of the central territories by using new trees in spring to meet the space requirements of the developing colony. Territorial expansion of the central and ground territories in autumn is suggested to be related to the increased food and space requirements of the developing brood. The circannual rhythm of territorial expansion in *O. smaragdina* is suggested to be correlated to the reproductive phase of the colony, since brood development may be serving as the proximate cue for increase in the number of nesting trees used (central territory) and expansion of the secondary territory on the ground. The correlation of the timing of nest building with the abundance of immature offspring and the coincidence of building with the start of the period when food availability reaches its peak in the habitat has been demonstrated by Fernandez-Escudero *et al.* (2001) in the

polygynous, polydomous ant species *Proformica longiseta*. A circannual rhythm in the territory size probably enables the populous *O. smaragdina* colonies to be prepared for favourable conditions (during the rainy season) when food (prey) is abundant.

Tree 'G' in colony I and 'c' in colony II with maximum duration of uninterrupted use and approximate central location in the colony territory, may be harbouring the queen nest. Although further work is needed to confirm that the queen nest is in the central tree; since workers carry the eggs to other nests in the colony, central location of queen occupied trees may be playing an important role in facilitating worker movements to the nests on the canopies of other trees. Thus, trees distantly located from tree 'G' and 'c' are used only at the time of favourable conditions and maximum territory use.

The information presented here, on the seasonal pattern in the territorial dynamics of *O. smaragdina*, is of significance as it can be used in context of the use of *O. smaragdina* as a biocontrol agent (DeBach and Rosen 1991; Hill 1983).

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## DETERMINING TROPHY HARVEST QUOTAS THROUGH A STATUS SURVEY OF URIAL (*Ovis orientalis*) IN THE KALABAGH GAME RESERVE, PUNJAB PROVINCE, PAKISTAN<sup>1</sup>

MICHAEL R. FRISINA<sup>2</sup>, GHULAM ALI AWAN<sup>3</sup> AND MICHAEL H. WOODFORD<sup>4</sup>

<sup>1</sup>Accepted May 23, 2005

<sup>2</sup>Montana Fish, Wildlife and Parks, 1330 West Gold Street, Butte, MT 59701, USA. Email: habitat@bresnan.net

<sup>3</sup>WWF-Pakistan, PO Box 5180, Lahore 54600, Pakistan. Email: gaawan@yahoo.com

<sup>4</sup>Apdo: 215, 8101 Loule, Algarve, Portugal. Email: mhwoodford@yahoo.com

In April 2001, a population survey of Urial (*Ovis orientalis*) was conducted in the Kalabagh Game Reserve, in northwest Pakistan, to determine its suitability for sustainable use management. During the survey, 259 Urial were observed (143 females, 20 lambs, 96 males). The 96 males were classified as 30, 19, 19, and 28; Class I, Class II, Class III, and Class IV rams, respectively. The number of lambs observed was low (7.7%) because the survey was conducted at or near the peak of lambing, when observing lambs is difficult. However, the high frequency of lambing activity we observed during the survey and proportion of Class I rams (male lambs of the previous year) indicates a productive population. An overall density of 13 Urial per sq. km was observed on the Reserve, but ranged from 7-23 per sq. km among sectors. Urial were abundant with good survival of lambs and yearling rams during recent years, and good survival of rams into older age classes. An initial conservative harvest quota of 5 Class IV rams could be established without negative consequences. Specific recommendations for sustainable use management are provided.

**Key words:** Urial, *Ovis orientalis*, sustainable use, population dynamics

### INTRODUCTION

The owners of the Kalabagh Game Reserve (KGR), in northwest Pakistan, were interested in the population status of Urial on their lands as of 2001. The goal was to have the government designate their privately-owned reserve a sanctioned community-based sustainable use hunting program. To accomplish this, it was necessary to conduct a population survey to determine suitability of the area. We summarize data resulting from the survey conducted during April 2001 and provide management recommendations.

### CONSERVATION STATUS

The taxonomic status of Urial is unclear and designation of various subspecies varies between authors (Clark 1964; Ellerman and Morrison-Scott 1966; Valdez 1982; Shackleton and Lovari 1997; Mitchell and Frisina 2007). In a synthesis of available information, Hess *et al.* (1997) considered the Urial at Kalabagh as the Punjab subspecies (*Ovis orientalis punjabiensis*). The Punjab subspecies is found as small, scattered populations throughout the Kala Chitta and Salt Range (Hess *et al.* 1997). The taxonomic status of Urial living along the west bank of the Indus River is uncertain (Schaller and Mirza 1974). All Urial are listed in Appendix II in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) except the Ladakh Urial (*Ovis orientalis vignei*), which is listed in Appendix I (USFWS 2001). The Punjab subspecies is listed as endangered in the IUCN Red List (IUCN 2000).

The Punjab Wildlife Protection, Preservation, Conservation and Management Act of 1974 protects Urial in Punjab Province from hunting, except under specific circumstances. Various wildlife protection laws enacted by the Pakistan National Government and Punjab Provincial Government are summarized by Hess *et al.* (1997). Urial at Kalabagh have been protected for the last 60 to 70 years by the Malik family who own the KGR and currently employ about 30 game guards.

### STUDY AREA

Established in the early 1930s, the KGR is located about 25 km southeast of the town of Kalabagh, Mianwali District, Punjab Province in a small massif that forms the most westerly extension of the Salt Mountain Range (32° 52' N, 71° 39' E). For many generations, this land has been the private property of the Nawab of Kalabagh. It was only in the 1930s, that the Urial were afforded special protection, and few were present at that time according to Nawab Malik Muhammad Asad (pers. comm. 2001). With shooting prohibited, except for limited trophy hunting by special permission, the Urial increased and in 1966 the population was estimated to be 500 (Mountfort 1969). Although declining in other portions of the Salt Range (Awan *et al.* 2004), the Urial population at Kalabagh has increased under protection, with the population estimated to be 700 in 1988 and 850 in 1992 (Hess *et al.* 1997).

Historically the Salt Range supported a spectrum of wildlife, including the Punjab subspecies (*Ovis orientalis punjabiensis*), Chinkara (*Gazella bennettii*), Chukor



(*Alectoris chukar*), See-See Partridge (*Ammoperdix griseogularis*), Grey Francolin (*Francolinus pondicerianus*) and Black Francolin (*Francolinus francolinus*) were plentiful due to the nature of the vegetation and topography. Important carnivores included Indian wolf (*Canis lupus pallipes*), Leopard (*Panthera pardus*), Jungle Cat (*Felis chaus*), Golden Jackal (*Canis aureus*), Red Fox (*Vulpes vulpes*), and Yellow-throated Marten (*Martes flavigula*). However, habitat destruction and uncontrolled hunting in the recent past have led to a marked reduction in the numbers and range of most species. Urial and Chinkara currently are the only large wild ungulates in the KGR. Wild Boar (*Sus scrofa*) is also present.

Livestock grazing within the KGR is limited to a few cattle and sheep that graze a short distance from the game guard headquarters at Jaba.

The Salt Range is an east-west trending thrust front about 175 km long and contains the second largest known mineral salt (sodium chloride) deposit in the world. The salt deposits are due to evaporation of the ancient Tethys Sea and formation of the Indus Plains from a collision of the Indian Plate with the Asian Plate resulting from continental drift 40 million years ago (King and Vincent 1993). Elevations in the Salt Range vary from 250 to 1,520 m. Sakesar Peak is the highest point at 1,524 m.

The dominant habitat type in the area is dry sub-tropical, semi-evergreen scrub forest (Roberts 1997). The important plant species are *Acacia modesta*, *Olea ferruginea*, *Salvadora oleoides*, *Zizyphus nummularia*, *Dodonaea viscosa*, *Prosopis glandulosa*, *Justicia adhatoda* and *Calotropis procera*. Shrubs are sparse, mostly scattered; *Zizyphus nummularia* and *Maytenus royleanus*, except in some ravines and on high ridges where *Dodonaea viscosa* is prominent. The predominant ground cover consists of grasses, importantly *Cymbopogon jwarancusa*, *Elusine compressa*, *Heteropogon contortus*, *Aristida adscensionis*, *Cynodon dactylon* and *Saccharum* sp.

Precipitation is in the form of rain. Data from the Meteorological Department weather stations at Mianwali, 30 km southwest of the KGR, provide an average annual rainfall of 454 mm for the 30-year period from 1961-1990. Rain is strongly seasonal with 60% falling during summer. Monsoon rains start around mid-July and last to mid-September. Winter rains begin in January and persist to early March. January is the coldest and June the warmest month of the year. Mean maximum daily temperature are usually >40° C in June.

## METHODS

All surveys were conducted from the ground while hiking. Urial were spotted from observation points and along

ridgeline travel routes. Drop-off points, base camp locations, and observation points were documented using GPS technology. Animals were observed with the aid of 8x and 10x binoculars. Relatively short sight distances made use of spotting scopes unnecessary. A group of 4 to 6 experienced observers went into the field together for 3 days (April 5-7, 2001) to observe sheep.

The habitat of the Urial at Kalabagh was divided into three sectors for survey purposes. Each sector was of a size and layout affording efficient coverage in one field day by the observation group. The area for each sector was estimated using field notes and GPS coordinates correlated to map coordinates on a 1:50,000 scale topographic map. The Dot Counting method was used to estimate the square kilometers for each sector. In this method, each dot represents a known area keyed to the scale of the base map employed.

Every effort was made to avoid counting an animal more than once. Each sector was surveyed only once, 1 sector per day, over a 3-day period. To minimize error, areas to be covered and distances to be traveled were carefully planned in advance. When the possibility existed that the same animals were observed more than once, only the first sighting was recorded.

Each Urial observed was classified into one of the following categories: adult ewe, lamb, or ram. Rams were further classified according to size, using horn length as an indicator of age, as follows: Class I (1-2 years old), Class II (3-4 years old), Class III (5-6 years old), and Class IV (>6 years old).

Location and altitude of sheep observation sites were recorded using a handheld GPS unit. Ram trophies previously harvested by hunters in the late 1960s and early 1970s and currently stored at Kalabagh were assigned an age by counting the number of annual growth rings using the method described by Geist (1966).

## RESULTS AND DISCUSSION

During the survey, 259 Urial were observed (143 females, 20 lambs, 96 males). The 96 males were classified as 30, 19, 19, and 28 – Class I, Class II, Class III, and Class IV respectively. During the survey, an average 86 Urial were observed per day in the field, indicating that Urial are abundant at Kalabagh. Urial were widely scattered throughout the area and many were observed as single animals or in groups of less than five.

### Population

In April 2001, an overall density of 13 Urial per sq. km was observed on the KGR, but the density varied with the survey sector, ranging from 7-23 Urial per sq. km. Comparing



data from an October 1970 survey with data from an April 1974 survey, Schaller (1977) reported Urial densities at Kalabagh of 11-13 per sq. km. However, Schaller's (1977) total census area was about 40 sq. km compared to our total census area, about 21 sq. km (Table 1). We only included habitat commonly used by Urial in our survey; lower elevation areas used primarily by Chinkara, but in which Urial are rarely observed, were not included.

The observed population structure at Kalabagh is summarized in Fig. 1. The largest proportion of rams in the population was Class I, indicating good survival of lambs and yearling rams during recent years. Mature Class IV or trophy-type rams were the second most abundant population segment, indicating good survival of males into older age classes. Class II and Class III rams each represented 19.8% of the male population segment, also indicating good survival.

In April, ewes are lambing at Kalabagh. During the survey, we found several newly born lambs and observed many ewes off by themselves apparently preparing for parturition. This is why the percentage of lambs (7.7%) observed is low. Lambs born the previous year were classified as either yearling (Class I) males or placed in the adult female category. Our observations indicate that this survey might have been conducted at or near the peak of lambing. The peak of lambing is a poor time to census the lamb population because newborn lambs are usually hidden from view.

More than half of all Urial observed were ewes (Fig. 1). The percentage of lambs observed would have been higher if the survey had been conducted after lambing was completed and the lambs had been old enough to travel with their mothers.

For the aforementioned reasons, data from this survey cannot be used to calculate an accurate lamb ratio for spring 2001. However, the high frequency of lambing activity we observed during the survey and proportion of Class I rams in the population indicates a productive population.

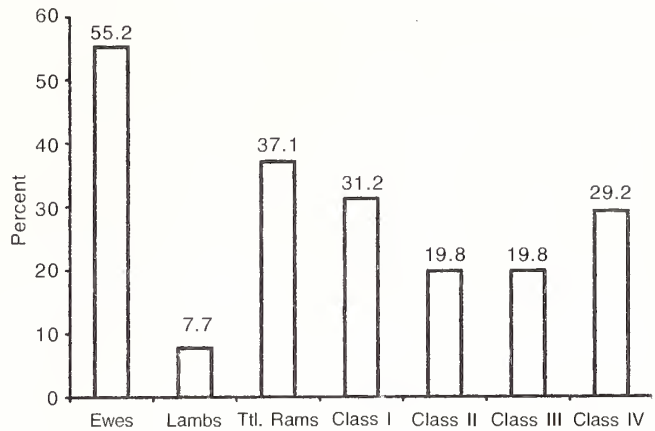


Fig. 1: Urial population sex and age structure as observed at Kalabagh, April 2001. Males by age class; I = 1-2 years old, II = 3-4 years old, III = 5-6 years old, IV = >6 years old

### Sustainable Harvesting

Currently the Urial population at Kalabagh is not hunted. Prior to implementation of the Punjab Wildlife Protection, Preservation, Conservation and Management Act of 1974, the population was trophy hunted for many years on a limited basis (6-10 Class IV males per year) (Malik Muhammad Asad pers. comm. 2001). Eight Class IV males harvested at Kalabagh by trophy hunters (prior to the 1974 Act) were aged. The mean age was 9.6 years at death and ranged from 8-11 years at death. These data indicate that rams lived up to old age and were harvested near the end of their natural lifespan.

If the KGR is designated a Government sanctioned community-based sustainable use hunting area, it is essential an initial hunting quota be established. The only recent population data available for Kalabagh is that collected during our April 2001 survey. April is a poor time of the year to census Urial population as ewes are scattered due to lambing, recently born lambs are difficult to observe, and rams are scattered across their range. The result is probably a significantly lower number of total animals observed by sex and age class than

**Table 1:** Size of the Kalabagh Urial range, survey area, and number of Urial observed by sector and sex or age class

Sector	Sq. km	Urial observed	Adult Males (Class III & IV) <sup>1</sup>	Other Males	Females	Lambs
1	8.5	63	16	16	27	4
2	6.4	144	24	18	88	14
3 (portion surveyed)	4.5	52	7	15	28	2
3 (portion not surveyed)	2.0	-	-	-	-	-
Total area surveyed	19.4	259	47	49	143	20
Total Area of Urial range	21.4					

<sup>1</sup>Class III = 5-6 years old, Class IV = >6 years old

would be observed during a time of year when ewes and rams are more visible, such as during the October-November breeding season. Most counts of wild animals underestimate the true total because not all animals are seen during the census (Caughley and Goodard 1972). Thus, using data from this survey to estimate a suitable sustainable hunting quota provides a very conservative number of animals appropriate for harvest, but may be suitable where the purpose is to establish an initial safe quota.

Following examination of literature on similar species and populations, Harris (1993) concluded that an annual harvest of trophy males in numbers equivalent to 2 percent of the total population size can be maintained without negative consequences. Using the approach described by Harris (1993) and assuming the 259 Urial observed during this survey is the total population, an initial trophy hunting quota for fall 2001 could be up to 5 trophy males. Harvesting of males within a limit of 10-20% of the replacement of the trophy-sized segment is consistent with Wegge (1997) as a safe and conservative harvest level for stable or increasing wild sheep and goat populations. During this survey, we observed 19 Class III (5-6 year old) males, which is the population segment of replacement animals for harvested Class IV males.

A trophy harvest quota of 5 Class IV males is a conservative and appropriate harvest level for sustainable management, but should be considered a maximum number, until additional population monitoring is conducted during the fall breeding season when a population estimate can be developed for monitoring population trend. Because of the aforementioned observational biases, data collected during this April survey was not used to make a population estimate.

## CONCLUSIONS AND RECOMMENDATIONS

A sustainable use trophy harvest quota of five rams

from the Class IV age group could be established without negative impact to the population.

An intensive survey using the protocols developed for this survey should be conducted as soon as possible during the fall breeding season to establish a baseline for determining population trend for future trophy hunting quotas.

A detailed analysis of the Urial population's habitat at Kalabagh should be conducted to include a description of the diversity and extent of plant communities present, and the ecological condition of soils and vegetation; information essential for determining habitat carrying capacity for Urial.

All trophies harvested should be aged and standard physical measurements taken of carcasses and horns. Field necropsy for disease, parasites, and assessing animal health at time of death should be performed on all harvested trophies. Special training for the Game Guards may be required, but such data is essential for proper population management.

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# FEEDING ECOLOGY OF INDIAN PORCUPINE (*HYSTRIX INDICA* KERR) IN COCONUT (*COCOS NUCIFERA* L.) PLANTATIONS OF THE WESTERN GHATS OF KARNATAKA<sup>1</sup>

A.K. CHAKRAVARTHY<sup>2,3</sup> AND A.C. GIRISH<sup>2</sup>

<sup>1</sup>Accepted May 28, 2005

<sup>2</sup>Department of Entomology, G.K.V.K., Bengaluru 560 065, Karnataka, India.

<sup>3</sup>Email: chakravarthyakshay@yahoo.com

Feeding ecology of the Indian Porcupine *Hystrix indica* Kerr in and around coconut plantations in the Western Ghats of Karnataka, southern India, was studied during 2001-2002. A survey of four districts in the study area showed that this species fed on 16 species of plants and was a major pest to the coconut plantations. It debarked the palm, fed on fallen nuts, injured seedlings to the point of no further growth, and bored into the bole eventually causing mortality. Mortality of the palms depended on age – the younger the palm, the greater the damage ( $r=0.9206$ ,  $P=0.05$ ).

The Porcupines feed on coconut bark, principally, from September to January. Burrows were categorized as small and big, and the number of Porcupines corresponded to the size of the burrows ( $r=0.8972$ ,  $P=0.05$ ). Encroachment of forest lands by man has resulted in alternative foods of the Indian Porcupine becoming locally scarce in the wild. Hence, conserving its natural habitat is critical.

**Key words:** Indian Porcupine, damage, coconut plantations, Western Ghats, southern India

## INTRODUCTION

The Indian Porcupine *Hystrix indica* Kerr (Family Hystricidae), a fossorial and nocturnal animal, is distributed throughout India from sea level to 2,800 m above msl (Agrawal and Chakraborty 1992). The Indian Porcupine *Hystrix indica* Kerr, the Himalayan Crestless Porcupine *Hystrix brachyura* Linn., and the Brush-tailed Porcupine *Atherurus macrourus* Linn. are the three species found in India (National Plant Protection Training Institute 1998). Porcupines inhabit a wide variety of habitats from semi-arid scrublands to forested areas (Prater 1980). The estimation of population density of porcupines in the Middle East, under various habitat and environmental conditions, has been attempted (Alkon 1983; Gutterman 1987, 1988). Bhargava *et al.* (2001) recorded observations on the distribution in western Thar Desert, Rajasthan, while Sharma (2001) estimated relative density in semi-arid areas of Rajasthan through pellet counts. Observations on bark feeding behaviour have been recorded by Choudhary and Ahmad (1975). Sharma (1989) and Sharma and Prasad (1992) documented information on tree debarking and habitat use by porcupine in Sariska National Park, Rajasthan. Field data on foraging ecology in cultivated ecosystems of the Western Ghats region in Karnataka has also been recorded. (Srihari and Chakravarty 2001). Chakravarty and Girish (2002a) evaluated cultural and mechanical methods to protect coconut from porcupine damage in coastal Karnataka. Chakravarty and Girish (2002b) also screened three varieties of coconut in coastal Karnataka and found equal feeding damage to all the varieties. In the

Western Ghats and coastal Karnataka, Coconut (*Cocos nucifera* L.) plantations adjacent to or near evergreen tropical forests were severely damaged by porcupines. This study reports basic information on the feeding behaviour and damage caused to coconut plantations.

## MATERIAL AND METHODS

### Identification of Vertebrate pests

Animals foraging in coconut plantations were identified by direct sighting using a pair of 8 x 30 binoculars and headlights. The nature of damage and signs in the field, such as presence of quills, pugmarks were used as clues for identifying animals.

### Study Area and Field Observations

Surveys were conducted using a four-wheel-drive vehicle during 2001 and 2002, in the districts of Shimoga (13° 51' 2.6" N, 75° 42' 25.9" E), Chikmagalur (13° 18' 44.3" N, 75° 46' 15.2" E), Hassan (5° 11' 15" N, 93° 35' 50" E), Kodagu (12° 24' 59" N, 75° 44' 8" E) and Dakshina Kannada (12° 51' 55" N, 75° 50' 29" E) in the Western Ghats of Karnataka, to document vertebrates feeding on coconut palms, alternate food plants, debarking pattern, temporal distribution of damage, feeding and foraging habits, and density and number of burrows per unit area. Alternate food plants were identified by a plant taxonomist. Damage by the Porcupine was correlated with its density, which was estimated from the number of burrows/unit area. Twelve (four at each location) porcupine burrows were excavated at Kidu, Bhadra and Sakleshpur. The number

of Porcupines in each burrow was counted, and the area and other details of the burrow were recorded at different times of the year. Debarking by porcupine was identified by gnawing marks on the trunks of trees and presence of quills. Debarking signs were categorised as new, old and cumulative (Sharma and Prasad 1992). To establish whether debarking by porcupines cause mortality in coconut palms, continuous observations were recorded on the progress of feeding damage like burrowing, debarking, removing fibrous tissue, feeding on pith, damaging bole portion and finally the death of the palm. The seasonal use of bark, the palm species most used and the age of the palm when bark stripping occurred commonly were documented. The Kruskal-Wallis One-way Analysis of Variance (Siegel and Castellan 1988) was used to test the seasonal difference in bark damage.

Porcupine damage on coconut palms was recorded during the early morning hours (0600-0800 hrs), every month. Total bark damage would be a function of maximum height above ground level to which the porcupines can debark (0.6 m) x average diameter of the trunk. Twelve palms in a five year old Benalium coconut garden plot of one hectare, adjacent to a forest were chosen to monitor the debarking process. Area (sq. cm) of bark removed daily by porcupines was also measured.

Damage was categorised as old, if it was more than a week old (damaged portion turning brown) and as new, if it was less than a week old (light yellow/ white coloured bark). The field data was subjected to ANOVA and least significant difference tests, damage and time being the main effects, with an interaction term of the main effects in the ANOVA model. Effect of palm age, distance of coconut plantation from forest

patch and coconut variety on porcupine damage was evaluated in separate coconut plantations from November 2001 to September 2002. Debarking pattern was recorded daily by marking the healthy palms fed upon by porcupine. For testing the hypothesis that palms of different age groups have different degrees of damage by porcupine, Friedman's One-way Analysis of Variance followed by LSD was performed. During April and May, at Subramanya, porcupines were found feeding on cashew kernels adjacent to the coconut plantations. Percent damage was computed by counting the total number of kernels accessible to the animal divided by the number of kernels eaten during peak fruiting period.

## RESULTS

### Field Observations

Six species of vertebrates, including porcupine, were found feeding on coconut palms (Table 1). The method of debarking of coconut by porcupines differed from that of other animals. Porcupines debarked the palm using their incisors, i.e. they chipped-out bark pieces, exposing the pith. The Cervids debarked the palm by rubbing their antlers on it, causing stripping, but the pith is not exposed. In the areas surveyed, the Indian Wild Boar (*Sus scrofa*) (30-40% nut damage) and Porcupine (15-20% nut damage) were considered major pests.

Surveys in the Sakleshpur, Arsikere and Hassan talukas of Hassan district, Subramanya of Dakshina Kannada district, Mudigere, Bhadra project area and Tarikere of Chikmagalur district indicated the presence of Porcupine in all talukas of the study area. Feeding signs were found on 13 species of

**Table 1:** Vertebrates feeding on Coconut Palms in the Western Ghats of Karnataka

Species	% damage		Nature of damage	Identification	Economic impact
	seedling	fallen nuts			
Bonnet Macaque <i>Macaca radiata</i>	7	15	Big hole in the centre of the nut, skin peeled off	Direct observation	Major
Five striped Squirrel <i>Funambulus palmarum</i>	0	1-2	Small hole in the centre of the nut	Direct observation	Minor
Bandicoot Rat <i>Bandicota indica</i>	16	3-5	Small hole near the perianth / proximal end of the nut	Tracks	Minor
Indian Wild Boar <i>Sus scrofa</i>	3	30-40	Dehusk the nuts into bigger pieces and eat the endocarp	Tracks	Major
Indian Porcupine <i>Hystrix indica</i>	24	15-20	Debark the trunk, dehusk into thin fibres / pieces	Presence of quills and tracks	Major
Indian Bison <i>Bos gaurus</i>	0	1-2	Damage the seedlings	Tracks	Minor

Major: >10%; Minor: <10%; seedlings: n = 200; fallen nuts: n = 80

cultivated and wild plants, besides coconut (Table 2). The Porcupines foraged on cultivated crops like potato, groundnut and sweet potato and also species of *Phoenix*. They inhabited hillsides, boulders, and burrows.

In parts of the hills and coastal Karnataka, Porcupines differentially fed on 16 species of plants (Table 3); the sample size in this case was small and represented a subset of the available species. Porcupines appeared to feed preferentially on certain plant species while avoiding others. Feeding signs were also observed frequently on *Ipomea batatas*, *Bambusa* spp., *Dioscorea* spp., Rubber *Hevea brasiliensis*, *Agave americana* and *Caryota urens*. The extent of damage to coconut depends on many factors – the most important being the age of the palm and the season. Seedlings and young coconut palms (less than 10 years) were more vulnerable to damage by porcupine feeding ( $t=4.261$ ,  $P=0.05$ ).

### Debarking

To assess the impact of porcupine feeding on cultivated

palm, the combined effect of burrowing, tissue feeding, bark stripping and browsing on ground vegetation was collectively considered. Porcupines debarked coconut palms of different ages, i.e. young (<5 years) to old palms (>30 years). The degree of damage caused differed with the age of the palm (Friedman's one-way ANOVA,  $P=0.05$ ); young palms (15-23 year) suffered significant damage compared to older palms (27-30 year) (LSD,  $P=0.05$ ). Most debarking occurred at the height of 0-75 cm. Debarking started from the bottom and progressed upward and sideways. No seasonal difference was found in the number of palms damaged by Porcupines (Kruskal-Wallis One-way Analysis of Variance  $P>0.05$ ).

Porcupines debarked about ( $n=12$ ) 44 sq. cm of bark from November to December 2001; 188 sq. cm bark/palm during December 2001 to January 2002; 250 sq. cm bark/palm during January 2002 to March 2002. However, the exact number of porcupines debarking coconut palms could not be established.

Cultivated coconut palms adjacent to the forest patch were more heavily damaged than those planted further away.

**Table 2:** Details of foraging by the Indian Porcupine on the crops and plants in the surveyed localities

Date	District	No. of visits	Geographic positions	Crops & plants with feeding signs
Nov. 24, 2001 to Nov. 8, 2002	Dakshina Kannada (Subramanya)	12	12° 51' 55" N, 75° 50' 29" E 281 m above msl	Cane <i>Calamus tenuis</i> Redt. Coconut <i>Cocos nucifera</i> L. Sweet Potato <i>Ipomea batatas</i> Lamk. Bamboo <i>Bambusa arundinacea</i> (Retz.) Tapioca <i>Manihot esculenta</i> Crantz. Alocasia <i>Alocasia indica</i> Schott. Cashewnut <i>Anacardium occidentale</i> L.
Jun. 1, 2002 to Sep. 17, 2002	Shimoga (B.R. Project)	4	13° 51' 2.6" N, 75° 42' 25.9" E 925 m above msl	Sweet Potato <i>Ipomea batatas</i> Lamk. Bamboo <i>Bambusa arundinacea</i> (Retz.) Tapioca <i>Manihot esculenta</i> Crantz Cane <i>Calamus tenuis</i> Redt. Coconut <i>Cocos nucifera</i> L.
Mar. 18, 2002 to Oct. 31, 2002	Chikmagalur (Mudigere)	3	13° 18' 44.3 " N, 75° 46' 15.2" E 982 m above msl	Cactus <i>Agave americana</i> L. Wild Turmeric <i>Curcuma aromatica</i> Salisb. Colocasia <i>Colocasia indica</i> L. Acacia <i>Acacia catechu</i> Willd.
Jan. 31, 2002 to Nov. 8, 2002	Hassan (Sakleshpur)	2 6	5° 11' 15" N, 93° 35' 50" E 100 m above msl	Banana <i>Musa paradisiacal</i> L. Cactus <i>Agave americana</i> L. Cane <i>Calamus tenuis</i> Redt. Wild Turmeric <i>Curcuma aromatica</i> Salisb. Colocasia <i>Colocasia indica</i> L. Gauri Gedde <i>Gloriosa superba</i> L. Byne Palm <i>Caryota urens</i> L.
Dec. 30, 2001 to May 24, 2002	Kodagu (Madikeri)	5	12° 24' 59" N, 75° 44' 8" E 1033 m above msl	Cactus <i>Agave americana</i> L. Wild Turmeric <i>Curcuma aromatica</i> Salisb. Colocasia <i>Colocasia indica</i> L. Gauri Gedde <i>Gloriosa superba</i> L.



Plot I was 0.3 km from forest, while plots II, III and IV were 0.8 km away. Plot I recorded 40% palm mortality, while plots II, III and IV recorded 10-22%. However, the effect of the distance from the forest was confounded with age, since palms differed in age between the plots. Porcupines caused higher mortality to younger palms. The data of the three plots equidistant from forest when analysed for palm mortality, showed a consistent relationship between age and mortality ( $r=0.9206$ ,  $P=0.05$ ). In general, it was observed during the surveys that palms less than ten year old were more vulnerable to damage.

One of the alternative food items in the study area was Cashew (*Anacardium occidentale*). Porcupines chewed the kernels, sucked the juice and left behind the kernels. Kernel damage due to porcupine feeding ranged from 6-12% (mean  $7.25 \pm 1.72$ ), while that due to other animals ranged from 11-17% (mean  $14.25 \pm 2.18$ ). During May 2002 porcupines did not use cashew kernels, but damage by other animals was 13%. Maximum damage to the cashew kernels by porcupine occurred during April when availability of kernels was high because of peak fruiting period. Damage was reduced drastically in May, when the fruiting season came to an end, as sufficient kernels were not available. There were no statistically significant differences in the damage caused by porcupines and other animals (T-test,  $P>0.05$ )

There were two types of porcupine burrows; the large burrows held 8-10 animals and small burrows held 2-3 animals. Seventeen (6 large, 11 small) porcupine burrows were located in 120 ha at Kidu, Subramanya, of which eleven were active,

and six deserted. Porcupines preferred scrub jungle for making burrows. Detailed observations in and around 150 ha of Subramanya showed that they tunnelled under shrub thickets and dense ground vegetation. Observations in a number of localities in the Western Ghats of Karnataka showed that usually 2-3 animals were found in small burrows ( $n=30$ ) compared to 8-10 in large burrows. Surveys in different parts of Hassan and Dakshina Kannada districts showed that one porcupine burrow could be located every sq. km. Twelve burrows, four at each site, were dug and exposed completely. The burrows consisted of a main entrance and several side entrances. The main entrance descended vertically to a depth of 3.5 m in the ground. The large burrows extended to more than 20 m and the small burrows to 8 m. The burrows had three ill-defined chambers; with a big central chamber, and one deep and another raised small chamber on either side. Food was hoarded in the big central chamber. Rearing of young was carried out in one of the small chambers, while the third chamber appeared to be used by the adults. Correlation analysis between the burrow size (sq. cm) and number of porcupines was positive ( $r=0.89725$ ,  $P=0.05$ ). However, correlation analysis between the number of porcupines and crop damage at a site showed a weak relationship ( $r=0.24310$ ), indicating that crop damage was not related to the number of porcupines in a locality.

## DISCUSSION

Porcupines proved to be a major pest in the coconut plantations in the study area (Table 1). In the Western Ghats region of Karnataka, porcupines injured Coconut, from seedling to mature palms. At the seedling stage, there was no compensatory growth and so the damaged seedlings were lost forever. This was also the case with Areca seedlings. Porcupines have adapted well from scrub jungles and forests to feeding on cultivated plants. Agrawal and Chakraborty (1992) recorded that the porcupines ate ripe fruits, bark of trees, sugarcane, maize, potato, sweet potato, carrot, onion, ripe melons and other tuberous and bulbous plants, and damaged forest plantations by girdling them. Thus, at each habitat the porcupines foraged on a number of cultivated and wild plant species. As also observed during the current study the porcupines did not depend on a single plant species. By foraging on several plant species, porcupines probably increased their survival rate and fitness. However, the economic loss as a result of porcupines feeding on coconut and arecanut is great, and hence urgent protection measures for the plantation near forests are required.

In the hill region of Karnataka, porcupines were found frequently feeding and damaging areca (*Areca catechu* L.)

**Table 3:** Percent utilization of some economically important and unimportant food plants by the Indian Porcupine in the coastal and hill regions of Karnataka

Food Plants	% damage
Sweet Potato <i>Ipomea batatas</i> Lamk.	3% of 20 tubers
Bamboo <i>Bambusa arundinacea</i> (Retz.)	8% of 25 tillers
Tapioca <i>Manihot esculenta</i> Crantz.	6% of 22 tubers
Alocasia <i>Alocasia indica</i> Schott.	2% of 15 tubers
Cashewnut <i>Anacardium occidentale</i> L.	10% of 200 nuts
Cane <i>Calamus tenuis</i> Redt.	5% of 35 tillers
Sweet Potato <i>Ipomea batatas</i> Lamk.	6% of 42 tubers
Ananus <i>Ananas comosus</i> (L.) Merr	6% of 350 plants
Banana <i>Musa paradisiaca</i> L.	2-8% of 150 plants
Cactus <i>Agave americana</i> L.	15-30% of 450 plants
Wild Turmeric <i>Curcuma aromatica</i> Salisb.	10-15% of 750 plants
Colacasia <i>Colacasia indica</i> L.	10-15% of 50 plants
Gauri Gedde <i>Gloriosa superba</i> L.	10-15% of 10 plants
Byne Palm <i>Caryota urens</i> L.	15-20% of 15 plants
Acacia <i>Acacia catechu</i> Willd.	3-5% of 75 fruits
Coconut <i>Cocos nucifera</i> L.	0.03% of 2000 plants

% refers to the number damaged out of the total number, from Jan. 17, 2002 to May 10, 2002

seedlings and coconut palms as they are being cultivated in newly cleared forest areas. Porcupines removed small amounts of bark at a time, around 0-75 sq. cm. As the frequency of debarking increased, the amount of damaged bark and the number of palms that were debarked also increased. Porcupines probably supplemented their diet with small quantities of bark which was not used as the main source of food. Debarking depended on a number of factors. In the study area, distance of coconut and arecanut plantations from the forest tract, where the animals usually lived, played an important role. Observations in coastal and hill regions of Karnataka revealed that nearer the plantation from the forest or burrows, higher was the damage inflicted by the porcupines. The porcupines used palm barks more frequently from September to January when the weather was humid and cool. Mortality of palms depended on age – the younger the palm, the greater the damage, and the two parameters were significantly correlated ( $r=+0.9206$ ). Young palms were probably preferred as they were easy to obtain and digest.

Small burrows were encountered more often than large burrows. The number of individuals corresponded to the size of the burrows ( $r=+0.89725$ ). However, porcupine density and crop damage at a site were not correlated. The number of animals varied depending on the size of the burrow (2-3 animals in small burrows, 8-10 in large burrows). However, more extensive observations are required to confirm this.

McIntyre (1972) proposed a number of hypotheses to explain bark stripping by ungulates, including the need for

high concentrations of trace elements and minerals found in bark, variation in nutritional quality between twigs and barks and low availability of high quality forage. However, the extent of damage to crops by *H. indica* has not been estimated. Further studies using radio-telemetry are in progress. In the Western Ghats, porcupines are frequently hunted for meat by tribals and locals. In addition to this, the natural habitat (forest) and the natural foods of the porcupines are declining rapidly. This may contribute to a decline in porcupine population in the near future. Ecological importance of porcupines in cultivated and natural habitat is yet to be documented. Currently, it is important to sustain natural foods of the animals in wild habitats. A strategy to conserve the species without resulting in severe economic damage to cultivated crops needs to be developed urgently.

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## LEOPARDS IN HUMAN-DOMINATED AREAS: A SPILLOVER FROM SUSTAINED TRANSLOCATIONS INTO NEARBY FORESTS?<sup>1</sup>

VIDYA R. ATHREYA<sup>2,3</sup>, SANJAY S. THAKUR<sup>2</sup>, SUJOY CHAUDHURI<sup>2</sup>, ANIRUDDHA V. BELSARE<sup>2</sup>

<sup>1</sup>Accepted July 2005

<sup>2</sup>Kaati Trust, D-103, GMRT Colony, Narayangaon 410 504, Pune district, Maharashtra, India.

<sup>3</sup>Email: phatrosie@gmail.com

In the past decade, many Indian states have reported an increase in Leopard (*Panthera pardus fusca*) populations outside forests, in certain areas, accompanied by a large number of attacks on people. This high density was attributed to declining natural habitats and prey species, and the increased survival of Leopards in croplands where they preyed on tamed, as well as feral domestic animals. That Leopard cubs were frequently found in agricultural fields was thought to also indicate rising Leopard populations. We use data from our human-leopard conflict study in Junnar, Maharashtra, along with information from three other conflict sites in India, to propose that the reason for this increase in Leopard population and conflict is related to the sustained translocation of 'problem' Leopards into nearby forests. That sustained releases could lead to population increases was never considered before, even though translocation is known to be a procedure for increasing populations of species at or close to the site of release. Although scientists do not recommend translocation as a management strategy for 'problem' carnivores, it is currently the legally recommended method of dealing with 'problem' large cats in India. Such faulty policies will only further hamper the conservation of this species, which is hunted in large numbers for illegal wildlife trade.

**Keywords:** translocation, *Panthera pardus fusca*, conflict, population increase, India

### INTRODUCTION

India has a history of human-large cat conflict (Seidensticker and Lumpkin 1991), but increasingly it is the Leopard *Panthera pardus fusca*, which is most often implicated in attacks on people (Athreya *et al.* 2004). Leopards have always lived on the fringes of human habitation (Prater 1948; Gee 1964; Santiapillai *et al.* 1982; Tikader 1983; Johnsingh 1992; Daniel 1996; WWF-India 1997), especially in India where the interface between forests and rural habitations is a continuum. This is possibly because the Leopard is a highly adaptable species capable of eating a wide variety of prey, and is not dependent on free water like its larger cousin, the Tiger (Prater 1948; Bertram 1982; Daniel 1996; Edgaonkar and Ravi 1997; Stander *et al.* 1997; Mukherjee and Mishra 2001; Kulkarni *et al.* 2004).

In the event of a Leopard problem, which can vary from just a sighting near a village to livestock predation or an attack on a person, the most common management strategy followed throughout India is: setting up of baited traps, capture of an individual (not necessarily the problem-causing individual) and its subsequent translocation into the nearest 'suitable' natural habitat. This is also recommended by the Indian Wildlife Protection Act (Anon 1972), through an amendment made in 2002. However, this strategy is not recommended by scientists for managing 'problem' animals (Linnell *et al.* 1997; Fischer and Lindenmeyer 2000; Sullivan *et al.* 2004), because of the strong homing instincts exhibited by a wide range of carnivore families, and the possibility of the conflict moving with the individuals. A recent study of the conflict in

Maharashtra by Athreya *et al.* (2004) has provided strong evidence of the same. Various Indian scientists and managers have also cautioned against this strategy for these reasons, as well as the potential disruption in the existing social setup of these highly territorial species by introduction of new individuals (Saberwal *et al.* 1994; Karanth and Sunquist 1995; WWF-India 1997; Edgaonkar and Ravi 1997; Karanth and Sunquist 2000).

The Indian states we will discuss in this paper, Maharashtra, northern West Bengal and Gujarat, have reported high human-leopard conflict levels for at least a decade (WWF-India 1997; Chauhan and Goyal 2000; Vijayan and Pati 2001; Athreya *et al.* 2004; Pati *et al.* 2004). These areas also report high densities of Leopards in human dominated areas and the principal reason put forward, essentially without evidence, is the decreasing natural habitat that compels the highly resilient leopard to move into human-modified habitats like tall crops, orchards (Gujarat), tea-gardens (northern West Bengal) and sugarcane fields (Junnar Forest Division, Maharashtra). Within these human-modified habitats, which provide good cover, it is thought that livestock and feral domestic animals provide an abundant supply of food in contrast to the depleting wild prey base (WWF-India 1997; Chauhan and Goyal 2000; Vijayan and Pati 2001; Field Director Buxa Tiger Reserve, pers comm).

We question this heuristic explanation and suggest that, ironically, far from being the panacea for managing conflict situations, the policy of translocation has resulted in increased Leopard populations colonizing the nearest suitable habitat, such as sugarcane fields and tea-gardens, thereby increasing



conflict potential. Finally, we suggest that increased Leopard populations reported from Sanjay Gandhi National Park, Mumbai, Maharashtra and affected areas in Uttarakhand, as well as Baria Forest Division, Gujarat are likely to have a very similar cause.

## METHODS

The human-leopard conflict study in Junnar Forest Division first quantified the extent to which translocation has been used as a management strategy to handle problem felids in India (Athreya *et al.* 2004). In this paper, we use data from Junnar and other sites, which report a history of conflict and view it in the context of translocation of Leopards into or near these sites.

Data on Leopard densities and conflict were collated for Junnar Forest Division, Sanjay Gandhi National Park (Mumbai, Maharashtra); the Terai, western Duars and eastern Duars regions (northern West Bengal) and areas around Gir National Park (Gujarat). The sources of information were the Forest Department records of Maharashtra, northern West Bengal and Gujarat, Edgaonkar and Ravi (1997), WWF-India (1997), Vijayan and Pati (2001), Khan *et al.* (2003), Athreya

*et al.* (2004) and Pati *et al.* (2004). Leopard densities for all sites, except northern West Bengal, have been estimated from actual number of animals trapped. In the case of northern West Bengal, the information was obtained from the Forest Department census figures. An idea of the numbers of Leopards living outside the forested areas is obtained from the number of cubs captured from tea-gardens and Leopards found dead. Information was also obtained from interviews with scientists and also past and present managers in these conflict areas (Field Director, Buxa Tiger Reserve; Deputy Chief Conservator of Forests, Junnar) to obtain a better understanding of the conflict patterns in various human-leopard conflict areas. Finally we corroborated our analysis with information from past scientific studies on translocated large cats.

## RESULTS

### Maharashtra

The two regions, which have reported high numbers of human casualties due to Leopard attacks in Maharashtra, are Junnar Forest Division, Pune district, and Sanjay Gandhi National Park (SGNP), Mumbai (Table 1).

**Table 1:** Leopard densities and numbers translocated into adjacent forests in four conflict sites in India

	Junnar <sup>1</sup>	Sanjay Gandhi National Park <sup>2</sup>	Northern West Bengal <sup>3</sup>	Gir <sup>4</sup>
Leopard densities	1 per 25 sq. km	1 per 3 sq. km	1 per 10 sq. km	1 per 7 sq. km
Habitat of conflict	Sugarcane fields	In and around protected area	Tea gardens	Sugarcane fields and mango orchards
No. of people attacked (period)	51 (2001-2003)	13 (June 2004)	121 (1990-1997)	27 (1990-1999)
Nearby sites of release (No. of Leopards released, period)	Malshej Ghats (25, 2001)	Bhootbangla Parisar (16, 2002-2003)	Gorumara National Park + Chapramari Wildlife Sanctuary (20, 1992-1997)	Gir National Park (38, 2001-2002)
	Bhimashankar Wildlife Sanctuary (11, 2001)	Nagla Block (5, 2002-2003)	Buxa Tiger Reserve + Jaldapara Wildlife Sanctuary (7, 1992-1997)	
			29 more were trapped but data on release is unavailable	
Distance of above site from site of conflict	< 60 km	< 20 km	< 20 km	< 50 km

<sup>1</sup>Data from Athreya *et al.* 2004

<sup>2</sup>Data from Forest Department Records

<sup>3</sup>Data from WWF-India 1997 and Field Director, Buxa Tiger reserve, pers. comm.

<sup>4</sup>Data from Vijayan and Pati 2001; Pati *et al.* 2004

The Maharashtra Forest Department Leopard census showed an increase from 20 animals in 1997 to 57 animals in 2001, in Junnar Forest Division. Livestock predation and attacks on people have been reported in this region since 1993, albeit at very low levels. It was only post-2001 that the conflict escalated sharply. The 4,360 sq. km of Junnar Forest Division is predominantly human-dominated and land cover analysis indicates no significant changes between 1992 and 2000. At the height of the conflict, approximately 1,600 sq. km of this area was affected (Athreya *et al.* 2004). Fifty-one people were attacked between 2001 and 2003, of whom 18 died (Junnar Forest Division records). Athreya *et al.* (2004) estimated a minimum population of 75 adult Leopards based on the number of individuals translocated, kept in captivity, and found dead, in this region between 2002 and 2003.

It has to be stressed that all the natural forests in Junnar Forest Division are confined to a narrow strip on the western edge along the ridge of the Western Ghats, while the rest of the division is totally devoid of natural cover. The hotspot of conflict was the irrigated valley of Narayangaon lying close to the eastern edge of the division and farthest from the forested Ghats. The rise in conflict was attributed to the ideal cover provided by sugarcane fields leading to increased Leopard populations. Forty-two Leopards were removed from the 390 sq. km of the Narayangaon range, either due to death, permanent captivity or far-off translocations (Athreya *et al.* 2004).

SGNP is a forested island inside the booming metropolis of Mumbai, and is the only site in India, which reports sustained human-leopard conflict from within the boundary of a protected area (Maharashtra Forest Department Records (MFDR), Edgaonkar and Ravi 1997). The Leopard population in SGNP increased from a handful of individuals in the early 1970s (J.C. Daniel, pers comm) to 35 in 1988 and 40 in 1996 (MFDR). Attacks on people have been reported since 1986, albeit in very low numbers (MFDR, Edgaonkar and Ravi 1997). Between March 2002 and March 2004, 24 attacks were reported, of which six occurred within the boundary of the Park (MFDR). In 2004, the number increased, with 13 attacks reported only in June 2004, of whom 10 people died (MFDR). After this, more than 30 leopards were trapped, indicating a minimum density of one Leopard per 3 sq. km and probably more. Clearly, any explanation for this extraordinary spurt in attacks has to involve a sudden trigger and not gradual processes like encroachments and reduction of wild prey base. The most common strategy of dealing with the Leopard 'problem' in SGNP has been their capture in baited traps and subsequent translocation into certain areas of the Park and adjacent forests (such as Tansa WLS which is about 150 km north-

east; see Edgaonkar and Ravi 1997). Between July 2002 and December 2003, 26 leopards were trapped, most of them outside the forest, of which 21 were translocated back inside the forest. The data available from Edgaonkar and Ravi (1997) indicates that this strategy has been in use for close to a decade now.

### Northern West Bengal

One hundred and twenty-one people were attacked in this region between 1990 and 1997 (WWF-India 1997), of whom 10 died (Table 1). Forest Department records until 2002 report the death of 18 people in leopard-related incidents. Of the three regions in Jalpaiguri district (Terai, eastern Duars and western Duars), the western Duars has experienced maximum conflict. Forest Department data reports that 13 people have died in the western Duars between 1990 and 2002, and 0 and 5 in the Terai and E. Duars respectively. Based on leopard attacks on people and livestock, as well as the number of cubs found, the WWF-India report (1997) identified 24 conflict hotspots in the region. Fifteen of these lie in the western Duars and within 15 km of Gorumara National Park and Chapramari Wildlife Sanctuary. The remaining nine occur in the eastern Duars at the fringes of Jaldapara Wildlife Sanctuary and Buxa Tiger Reserve. The census figures for 1999 report 159 leopards in the forest areas with a density of one per 10.85 sq. km (<http://www.wb.nic.in/dist/jalpai.html>). There are reports of a large number of Leopard deaths due to conflict related incidents in this region; five in the Terai region between 1993 and 1996, 20 in western Duars between 1990 and 1997, and 14 in the eastern Duars between 1990 and 1996 (WWF-India 1997). Of these 39 deaths, 25 were caused by people (either mob related or poisoning or shot at).

### Gir National Park, Gujarat

The Gir National Park is a forested island, home to the Asiatic Lion and the Leopard. However, both these large cats are increasingly reported in conflict incidents on the periphery of the Park (Vijayan and Pati 2001). Gir National Park reports very high densities of both, the Asiatic Lion (one per 5-7 sq. km) and the Leopard (one per 7 sq. km) (Vijayan and Pati 2001, Table 1). A study carried out in one of the areas affected by human-leopard conflict (Talala sub-district/taluka) adjacent to the Park reported 27 leopard attacks on people between 1990 and 1999, of which four were fatal (Vijayan and Pati 2001). However, the common management strategy in dealing with Leopards and Lions that are found outside of the Park is their capture and release within the National Park (Saberwal *et al.* 1994; Vijayan and Pati 2001; Khan *et al.* 2003). An average of 50 Leopards are translocated into the National Park each year (Vijayan and Pati 2001; Khan *et al.* 2003). Thirty-two leopards



were rescued and 12 found dead between 1990 and 1998 from the Talala subdistrict alone. Eleven lions were rescued and eleven found dead due to poisoning or falling into wells (Vijayan and Pati 2001), during the same period.

## DISCUSSION

The Leopard occurs throughout India and has always been reported from areas bordering human habitation (Prater 1948; Daniel 1996; Seidensticker and Lumpkin 1991), but severe conflict is reported only from pockets across the country. Leopards occur in tea-gardens of Assam and southern India, but no conflict comparable to that in northern West Bengal has been reported. Sugarcane occurs in many parts of Maharashtra with far more extensive tracts in the southern areas of Kolhapur and Karad, situated at the same distance from the Western Ghats as in Junnar, but without comparable conflict levels (Athreya *et al.* 2004). Even in those forest divisions that report human-leopard conflict, the problem is confined to a small sub-region. For example, in Junnar, the conflict that started in 2001 was concentrated in the Narayangaon valley; the hotspots of the conflict in SGNP in 2004 were close to the Ghodbandar and Film City areas; in Gir it is the subdistricts/talukas of Visavadar, Malia and Talala (Saberwal *et al.* 1994); in northern West Bengal most of the hotspots identified by WWF-India (1997) were in the western Duars, a few in the eastern Duars, while none in the Terai region.

The theories commonly put forth to explain human-leopard conflict are loss of natural habitat and wild prey and the subsequent movement of leopards to 'ideal' irrigated areas and the associated domestic animals. An important aspect that was not considered was the sustained translocation of Leopards for at least a decade into or close to these sites. The Junnar study by Athreya *et al.* (2004) looked into the patterns of conflict on a landscape level and they found that the conflict was not present close to the sites of release, but commenced about 15 km away, with the hotspot of conflict ranging 40-60 km away from the site of release (Athreya *et al.* 2004). A translocation exercise in Kenya in the late 1970s provides an insight into why this might be. Radio telemetric studies showed that eight Leopards translocated more than 200 km into a National Park, in response to livestock predation, immediately moved a distance of 25 km away from the release site (Cobb 1981). It is likely that a hard release into an alien area makes these highly territorial animals leave the area in the direction of home, a phenomena seen across carnivore species (Linnell *et al.* 1997). In all the conflict sites discussed in this paper, except SGNP, the areas with highest vegetation density immediately outside forested release sites are human-

modified croplands. A sustained release of Leopards into a few release sites over many years is likely to have led to the high Leopard numbers seen in irrigated fields, tea-gardens and even in the single protected area of SGNP.

Moreover, natural leopard populations are already present at these release sites. For example, census figures for the Bhimashankar Wildlife Sanctuary (MFDR, Kulkarni *et al.* 2004) reported 10 leopards. In 2001, 11 leopards trapped in the Junnar Forest Division were released close to the Wildlife Sanctuary. In the absence of leopard-free forests in the surrounding area and in their attempt to leave the site they would naturally move down the river valleys that contain irrigated fields with high vegetation density. High levels of conflict were reported for the first time in five years in these areas following the translocations (Athreya *et al.* 2004).

Translocation is the most common management strategy used in our country in response to any problem associated with the large cats (lions, tigers and leopards), and is recommended by law. Translocation as the preferred method of dealing with 'problem' Schedule 1 species was introduced as late as 2002 as an amendment to the Wildlife Protection Act (Anon 1972). However, translocation is also the preferred method to establish or increase the presence of a species near the site of release (IUCN 1987) and has rightly been recommended for founding a second home the Asiatic Lions outside Gujarat (Chellam *et al.* 1994). The Florida panther study shows how large cat populations increase following translocation (Ellis *et al.* 1999). In 1995, the 8 female Florida panthers that were released had increased to 21 individuals by 1999 due to new births. Furthermore, translocation is not recommended for problem carnivores for reasons rooted in their biology (such as very strong territoriality and consequent post-release movements, movement of the conflict with the individual, social disruption of existing leopard populations at site of capture, as well as release, introduction of pathogens to the new sites of release, see Rabinowitz and Nottingham 1986; Linnell *et al.* 1996; 1997; Khan *et al.* 2003; Treves and Karanth 2003; Athreya *et al.* 2004). Furthermore, our data shows that population increases can also occur close to the release site and that in the absence of forested areas devoid of conspecifics, the animals will colonize adjoining human-modified habitats such as crop fields and tea-gardens.

The state of Uttaranchal has had a history of human-leopard conflict; around 140 people succumbing to Leopard attacks between 1988 and 2000, while 93 leopards were killed in the same period (UA Forest Department records in Chauhan and Goyal 2000). Rajaji and Corbett National Parks are reported to be sites of release for Leopards trapped elsewhere in the state. An analysis of the capture and release



sites and dates, overlaid on maps of vegetation density and river systems could test our hypothesis that sustained translocations into the nearby forested areas have created the hyper-dense Leopard populations of 3-4 per 10 sq. km reported in the Pauri region (Chauhan and Goyal unpublished report of the Wildlife Institute of India, Dehradun.). That Pauri is not in the immediate vicinity of the forested sites (about 40 km away), may not be an issue. Even in Junnar, the conflict area - Narayangaon, and the release site - Malshej, are 40 km apart, with few attacks reported in the intervening area. In the complete absence of post-release monitoring of large numbers of translocated leopards, we do not have any information on how these animals use the new areas of release and their movements across the landscape in their attempt to head back home. A leopardess trapped in Junnar was marked with a transponder chip and released in the forests at the Madhya Pradesh-Maharashtra border. She moved 90 kms in the direction of Junnar and in the process, resulted in 6 human fatalities and a similar number of injuries (Belsare and Athreya 2004 [http://carnivoreportal1.free.fr/archives2004\\_3.htm](http://carnivoreportal1.free.fr/archives2004_3.htm)). In keeping with the known biology of the species, her route was along the river valleys in human dominated areas, just as we inferred for the Malshej-Narayangaon leopards (Athreya *et al.* 2004).

Felid biology explains why problems even at the site of capture do not decline following large removals of leopards. Sub-adult felids are known to incur high mortality rates due to poor hunting success and due to killings by resident males (Cramer and Portier 2001). The removal of 12 mountain lions (similar in size to leopards) in Utah, USA, following livestock depredations did not change conflict levels because 17 different, and younger individuals moved in to occupy the vacant territories (Linnell *et al.* 1996). If landscape features do not allow translocated individuals to home all the way back to their territories, their vacant territories will be filled up by younger individuals while the survival of the translocated mature individual close to the new site will indeed increase the overall leopard population over a period of time. Furthermore, landscape features just outside of the release sites are likely to determine the extent to which the newly released animals can use them. Availability of prey is not an issue for leopards living in human dominated areas due to the abundance of feral dogs and domestic livestock. It is well known that domestic dogs are commonly taken by leopards (Mukherjee and Mishra 2001; Edgaonkar and Ravi 1997). Most leopards trapped in India are from outside natural habitats. Following their release into forested sites it is likely that they will move towards human settlements thereby perpetuating

conflict. This has indeed been shown to be true (Khan *et al.* 2003; Athreya 2006).

In conclusion, the consistent pattern of high Leopard density seen in various areas reporting human-leopard conflict (many parts of Maharashtra, northern West Bengal, Gujarat, Uttarakhand) is likely due to their proximity to 'preferred' release sites of Leopards, effectively re-stocking the area with Leopards. Habitats such as tea-gardens in northern West Bengal, sugarcane in Junnar, orchards around Gir will provide the next best habitat for colonisation for the released animals and their progeny. Therefore, when analysing human-carnivore conflict patterns, it is also important to take into account the numbers of animals that are trapped and released and the proximity of release sites to the conflict sites. For instance, Himachal Pradesh reported 70 Leopard trappings between 1997 and 2003 (Athreya *et al.* 2004), and also reported conflict, but we could not access data on the fate of these captured animals. The Baria Forest Division in Gujarat reported 121 attacks on people by Leopards in 2000 (Gujarat Forest Department records in Athreya *et al.* 2004). Releases of Leopards are also reported close to Baria Division, but we lack factual data to discuss the issue. Translocation of problem Leopards was also carried out in Meru National Park, Kenya, where 108 Leopards were released over 11 years until 1979 (Cobb 1981). It would be interesting to know if the areas outside of the release site reported increased Leopard numbers in those years.

Following Linnell *et al.* (1997), we also recommend that translocation of problem carnivores should not be carried out. With our faulty methods of dealing with Leopards – a species capable of living close to human settlements – we have only perpetuated conflict and increased it to alarming levels in recent years. It is of serious concern that the amendment to Section 11 of the Wildlife Protection Act was made a full five years after a scientific review (Linnell *et al.* 1997), which advised against such a management strategy. It is imperative that past studies and the biology of species as well as experiences of managers be considered when changing or making policy decisions.

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## FISH BIODIVERSITY IN THE WATER BODIES OF SAMASPUR BIRD SANCTUARY, UTTAR PRADESH: TOWARDS DEVELOPING A FRESHWATER AQUATIC SANCTUARY<sup>1</sup>

U.K. SARKAR<sup>2,3</sup>, D. KAPOOR<sup>2</sup>, S.K. PAUL<sup>2</sup>, A.K. PATHAK<sup>2</sup>, V.S. BASHEER<sup>2</sup>, P.K. DEEPAR<sup>2</sup>, S.M. SRIVASTAVA<sup>2</sup> AND L.K. TYAGI<sup>2</sup>

<sup>1</sup>Accepted November 2005

<sup>2</sup>Endangered Fish Biology and Systematics Lab, National Bureau of Fish Genetic Resources, Canal Ring Road, Dilkusha, Lucknow 226 002, Uttar Pradesh, India.

<sup>3</sup>Email: usarkar1@rediffmail.com, uksarkar@nbfgr@res.in, nbfgr@sancharnet.in

Extensive surveys were conducted in Samaspur Bird Sanctuary (799.37 ha), Uttar Pradesh during June 2000 to December 2004, to explore the status of fish germplasm resources in the water bodies. A total of 3,444 fish were collected and classified into 7 orders, 19 families, 33 genera and 46 species. One exotic species (n=2) *Aristichthys nobilis* was collected. This is the first ichthyofaunal report of this Sanctuary. The dominant species was *Gudusia chapra* (relative abundance, 7.25%) and the subdominant species were *Labeo bata* (RA, 6.67%), *Salmostoma bacaila* (RA, 5.51%), *Amblypharyngodon mola* (RA, 5.08%), *Notopterus notopterus* (RA, 4.50%) and *Eutropiichthys vacha* (RA, 3.91%).

The analysis showed that 28.26% of fish species, which are reported to be threatened as per IUCN, had a stable population in the Sanctuary. Apart from the major Indian carps and the above-mentioned species, the important species recorded were *Chitala chitala*, *Chupisoma garua*, *Ailia coila*, *Aorichthys aor*, *Wallago attu*, *Labeo gonius*, *Labeo pangusia*, *Puntius sarana*, *Rhinomugil corsula*, *Channa marulius*, *Channa striatus*, *Ompok pabda* and *Ombok pabo*. The study confirms that protected freshwater areas are important for conservation of regional fish biodiversity, especially for local and endangered fish species.

**Key words:** Samaspur Bird Sanctuary, fish biodiversity, threatened fish, aquatic Sanctuary

### INTRODUCTION

Protected areas could play an important role in the conservation of fresh water fishes in India, but first there is a need to identify the conservation value of these areas in relation to the biogeographical diversity of fishes, and the factors that have an impact on fish communities. The fish diversity of India is declining rapidly, due to urbanization, pollution, damming and diversion of waters for irrigation and power generation, which have, in the last few decades, subjected our natural water bodies in general, and rivers in particular, to severe stress. Provision of a secure habitat is important to protect the genetic resources of fresh water fish. In India, rivers, streams, wetlands and beels of existing protected areas offer good opportunities for creating fresh water aquatic sanctuaries. The current protected area network encompasses almost 4.66% (c. 153,000 sq. km) of India's geographical area in over 480 sanctuaries and 86 national parks (Rodgers *et al.* 2000). There are reports of illegal fishing within protected areas (Wakid and Biswas 2003). India is endowed with about 2,163 fish species, so far, as has been documented by the National Bureau of Fish Genetic Resources (Anon 2004), of which about 700 species inhabit fresh water. Jayaram (1999) has, however, reported 2,500 species with 930 freshwater inhabitants. A detailed inventory of fish and habitat parameters in the protected areas will indicate the present status of threatened freshwater fishes in these water bodies.

In the present study, a detailed survey was conducted in the water bodies of Samaspur Bird Sanctuary, Rae Bareilly to ascertain the present scenario of fish biodiversity within protected areas. This study is the first attempt to explore the fish diversity potential within Samaspur Bird Sanctuary.

### STUDY AREA

Samaspur Bird Sanctuary is situated in Salon, Rae Bareilly district of Uttar Pradesh (Fig. 1). It is spread over 799.37 ha and has lentic water bodies comprising of six small inter-connected lakes, with a water area of 305.46 ha. The lakes are perennial and the main water sources are the various tail ends of canals, which are connected to these lakes. During flooding these lakes drain into villages adjacent to these lakes.

### MATERIAL AND METHODS

Monthly sampling was carried out using stratified random methods. The total water body was divided into three sampling zones. Positional coordinates of the sampling points of the water bodies were, 25° 59.55' N, 81° 23.32' E and 25° 59.92' N, 81° 23.51' E, mean altitude 98.37 m above msl. The fish sampling was done in many points covering all representative habitat of the Sanctuary. Various mesh size of gill nets, cast nets and dragnets were used for sampling. Colour spots, if any, maximum size and other characters of the fishes





Fig. 1: Map of India showing the location of the Sanctuary

caught were recorded and the samples were preserved in 10% formalin solution. Talwar and Jhingran (1991) and Srivastava (1988) were followed for fish identification. References to conservation status categories within this paper are based on IUCN classification as per CAMP-NBFR (1998).

## RESULTS AND DISCUSSIONS

The present study indicates that water bodies within Samaspur Bird Sanctuary have a rich biodiversity of freshwater fish. A total number of 46 species from 7 orders, 19 families, and 33 genera were documented during the study period. Cyprinids were the dominant group (38.4%), followed by Perciformes (23.07%) and Siluroids (15.38%). Chinese big head carp *Aristichthys nobilis* (n=2) was recorded on one occasion, probably an escapee from culture system to natural waters. The forty-six species documented are listed in Table 1 along with their conservation status, local name and size distribution. The dominant species was *Gudusia chapra* (RA, 7.25%), and the subdominant species were *Labeo bata* (RA, 6.67%), *Salmostoma bacaila* (RA, 5.51%), *Amblypharyngodon mola* (RA, 5.08%), *Notopterus notopterus* (RA, 4.50%) and *Eutropichthys vacha* (3.91%). An important observation was that 28.26% of fishes that come under the threatened category in other areas were stable in the Sanctuary waters. This was recorded during experimental sampling of the waterbodies throughout the study period (2000-2004).

In India, efforts have been made recently in bringing together the studies of fish diversity in various rivers with regard to freshwater habitat. However, fish diversity of many water bodies within protected area network is not yet investigated and the information related to species diversity, conservation status of many species is unknown. Review of literature indicates that few reports on fish diversity within protected water bodies are available. Arunachalam and Sankaranarayanan (1999) published a list of 31 species of fishes from streams in Gadana river basin located in the buffer zone of Kalakkad Mundanthurai Tiger Reserve of Western Ghats, of which 4 species were reported to be first records by the authors from Gadana river. Biju *et al.* (1999) described 40 freshwater fish species from Prambikulam Wildlife Sanctuary Palakkad district, Kerala. *Labeo calbasu*, *Puntius sarana*, *Puntius ticto*, *Chanda ranga* and *Mastacembelus armatus* were reported by Arunachalam and Sankaranarayanan (1999) from Gadana river in Kalakkad Mundanthurai Tiger Reserve. Sarkar *et al.* (2002) described a record size (22.5 cm TL) of *Gudusia chapra* from the waterbodies of Samaspur Bird Sanctuary. Interestingly, the average total length of many of the fishes sampled was larger than fishes available outside the Sanctuary and natural waters.

## Major Threats and Recommendations for Conservation

Presently, the flora and fauna of Indian national parks and sanctuaries are legally protected from human intervention. However, the boundaries of these areas are not large enough to encompass the entire ecosystem, and many stresses that affect the aquatic habitat originate beyond sanctuary boundaries. Until now, most water bodies within protected areas have been insufficiently recognized in India. The primary objective for successful conservation of the high fish diversity within the protected area network must be to develop effective controls and management practices that enable life cycle completion, dispersal and population maintenance within stream systems. Drastic ecological and anthropogenic changes of forest and aquatic habitat outside protected water bodies are great threats for fish biodiversity, as well as aquatic habitat. Spreading of fish diseases due to water pollution, over exploitation of fish fauna, use of poison, river alterations etc. are the main threats to fish fauna. Unless we take timely measures, these valuable resources will become endangered or extinct. Based on our observations, we recommend the following for management of fish biodiversity in a scientific manner.

1. The aquatic bodies within the Sanctuary should be declared as an aquatic sanctuary.
2. Afforestation programme should be intensified on the banks of water bodies.

**Table 1:** Fish diversity of Samaspur Bird Sanctuary, Rae Bareilly, Uttar Pradesh

Sl. No.	Scientific name	Family	Common name	IUCN status	Maximum total length (cm)
1.	<i>Chitala chitala</i> (Hamilton)	Notopteridae	Moye	EN	85.3
2.	<i>Notopterus notopterus</i> (Pallas)	Notopteridae	Patra	LRnt.	27.1
3.	<i>Gudusia chapra</i> (Hamilton-Buchanan)	Clupeidae	Suhia	LRlc.	22.5
4.	<i>Amblypharyngodon mola</i> (Hamilton-Buchanan)	Cyprinidae	Dhawai	LRlc.	18.2
5.	<i>Aristichthys nobilis</i> Richardson	Cyprinidae	Big-head	NE	45
6.	<i>Catla catla</i> (Hamilton-Buchanan)	Cyprinidae	Bhakur, Katla	VU	71
7.	<i>Cirrhinus mrigala</i> (Hamilton-Buchanan)	Cyprinidae	Nainee	LRnt.	66.5
8.	<i>Danio devario</i> (Hamilton-Buchanan)	Cyprinidae	Patukari	LRnt.	8.9
9.	<i>Labeo bata</i> (Hamilton-Buchanan)	Cyprinidae	Bata	LRnt.	38
10.	<i>Labeo calbasu</i> (Hamilton-Buchanan)	Cyprinidae	Kauranchi	LRnt.	57.3
11.	<i>Labeo gonius</i> (Hamilton-Buchanan)	Cyprinidae	Kursha	LRnt.	56
12.	<i>Labeo pangusia</i> (Hamilton-Buchanan)	Cyprinidae	Rewa	LRnt.	29.8
13.	<i>Labeo rohita</i> (Hamilton-Buchanan)	Cyprinidae	Rohu	LRnt.	75
14.	<i>Puntius chola</i> (Hamilton-Buchanan)	Cyprinidae	Puthi, Siddhari	NE	11.5
15.	<i>Puntius sarana</i> (Hamilton-Buchanan)	Cyprinidae	Puthi	VU	22.5
16.	<i>Puntius sophore</i> (Hamilton-Buchanan)	Cyprinidae	Pothi	LRnt.	12.5
17.	<i>Puntius ticto</i> (Hamilton-Buchanan)	Cyprinidae	Pothia	LRnt.	8.5
18.	<i>Salmostoma bacaila</i> (Hamilton-Buchanan)	Cyprinidae	Chelwa	LRlc.	10
19.	<i>Nemacheilus botia</i> (Hamilton-Buchanan)	Cyprinidae	Natwa	LRnt.	6.0
20.	<i>Aorichthys aor</i> (Hamilton-Buchanan)	Bagridae	Tengra	LRlc.	76
21.	<i>Mystus vittatus</i> (Bloch)	Bagridae	Tengra	VU	14.1
22.	<i>Rita rita</i> (Hamilton-Buchanan)	Bagridae	Hunna	LRnt.	40.7
23.	<i>Ompok pabda</i> (Hamilton-Buchanan)	Siluridae	Pabda	EN	15.5
24.	<i>Ompok pabo</i> (Hamilton-Buchanan)	Siluridae	Pabda	VU	14.4
25.	<i>Wallago attu</i> (Schneider)	Siluridae	Parhen, Barari	LRnt.	81.0
26.	<i>Ailia coila</i> (Hamilton-Buchanan)	Schilbeidae	Banspatti, Patasi	VU	13.2
27.	<i>Eutropiichthys vacha</i> (Hamilton-Buchanan)	Schilbeidae	Bachwa	EN	27.5
28.	<i>Clupisoma garua</i> (Hamilton-Buchanan)	Schilbeidae	Baikeri	VU	18.9
29.	<i>Clarias batrachus</i> (Linnaeus)	Clariidae	Magur	VU	29.7
30.	<i>Heteropneustes fossilis</i> (Bloch)	Heteropneustidae	Singee	VU	26.8
31.	<i>Xenentodon cancila</i> (Hamilton-Buchanan)	Belontiidae	Kakhya, Thona	LRnt.	23.0
32.	<i>Monopterus (Amphipnous) cuchia</i> (Hamilton-Buchanan)	Synbranchidae	Cuchia	NE	45.6
33.	<i>Chanda nama</i> Hamilton-Buchanan	Ambassidae	Chanari	LRlc.	4.2
34.	<i>Parambassis ranga</i> (Hamilton-Buchanan)	Ambassidae	Chanari	LRlc.	5.3
35.	<i>Glossogobius guiris</i> (Hamilton-Buchanan)	Gobiidae	Bulla	LRnt.	6.3
36.	<i>Channa marulius</i> (Hamilton-Buchanan)	Channidae	Sauri	LRnt.	39
37.	<i>Channa orientalis</i> Bloch & Schneider	Channidae	Girohi	VU	12.2
38.	<i>Channa punctatus</i> (Bloch)	Channidae	Girohi	LRnt.	14.5
39.	<i>Channa striatus</i> (Bloch)	Channidae	Sauri	LRlc.	14.2
40.	<i>Macrogathus pancalus</i> Hamilton-Buchanan	Mastacembelidae	Basmi, Pataya	LRnt.	16.2
41.	<i>Mastacembelus armatus</i> (Lacepede)	Mastacembelidae	Baam.	LRlc.	56
42.	<i>Rhinomugil corsula</i> (Hamilton-Buchanan)	Mugilidae	Korsul, Answari	LRnt.	11.5
43.	<i>Nandus nandus</i> (Hamilton-Buchanan)	Nandidae	Vaadhul	LRnt.	14.8
44.	<i>Anabas testudineus</i> (Schneider)	Anabantidae	Kobai,	VU	15.1
45.	<i>Colisa fasciatus</i> (Schneider)	Belontiidae	Khosti	LRnt.	10.0
46.	<i>Colisa lalia</i> (Hamilton-Buchanan)	Belontiidae	Khosti	LRnt.	4.7

\* EN = Endangered; LRnt. = Lower Risk near threatened; LRlc. = Lower Risk least concern; VU = Vulnerable; NE = Not evaluated

3. Periodic monitoring of water quality parameters.
4. Existing suitable habitat should be protected from erosion and deterioration of water quality.
5. Maintain water depth; should not be less than 1-2 m.
6. Poisoning by villagers from the nearby villages should be stopped by regular monitoring.
7. Community awareness programme for increased participation in conservation.
8. Legislation should be implemented strictly for illegal activities.
9. Strengthening of manpower for scientific management of water bodies and fisheries.
10. Ranching programme can be undertaken for selective fishes, which are not abundant in the protected area.

There is need for more surveys so that more new records could be documented. The availability of fish species larger than that reported in literature, and occurrence of many threatened species in these protected water bodies, indicates the urgent need for developing a fresh water sanctuary, with scientific management.

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## NEW DESCRIPTIONS

TWO NEW SPECIES OF *MELINDA* ROBINEAU-DESVOIDY  
(DIPTERA: CALLIPHORIDAE) FROM INDIA  
WITH A KEY TO THE INDIAN SPECIES OF THIS GENUS<sup>1</sup>DEVINDER SINGH<sup>2, 3</sup> AND Inderpal Singh Sidhu<sup>2, 4</sup><sup>1</sup>Accepted January 24, 2005<sup>2</sup>Department of Zoology, Punjabi University, Patiala 147 002, Punjab, India.<sup>3</sup>Email: devinder\_ss@india.com<sup>4</sup>Email: inderpalsidhu76@yahoo.co.in

Two new species of *Melinda*, *M. chambaensis* sp. nov. and *M. chandigarhensis* sp. nov. are described from India. A key to the five species of this genus known from India is given.

**Key words:** *Melinda*, Diptera, Calliphoridae, new species

## INTRODUCTION

The genus *Melinda* is represented by 26 species from the Oriental region, including three from India. There has been some controversy regarding the taxonomic status of this genus and that of *Paradichosia* Senior-White. Senior-White *et al.* (1940) kept them as distinct genera while Kurahashi (1970) synonymised the two. Because Fan *et al.* (1992) again assigned them independent status, we consulted Dr. Kurahashi (pers. comm.), who is of the firm opinion that *Paradichosia* should be considered a junior synonym of *Melinda* and we agree.

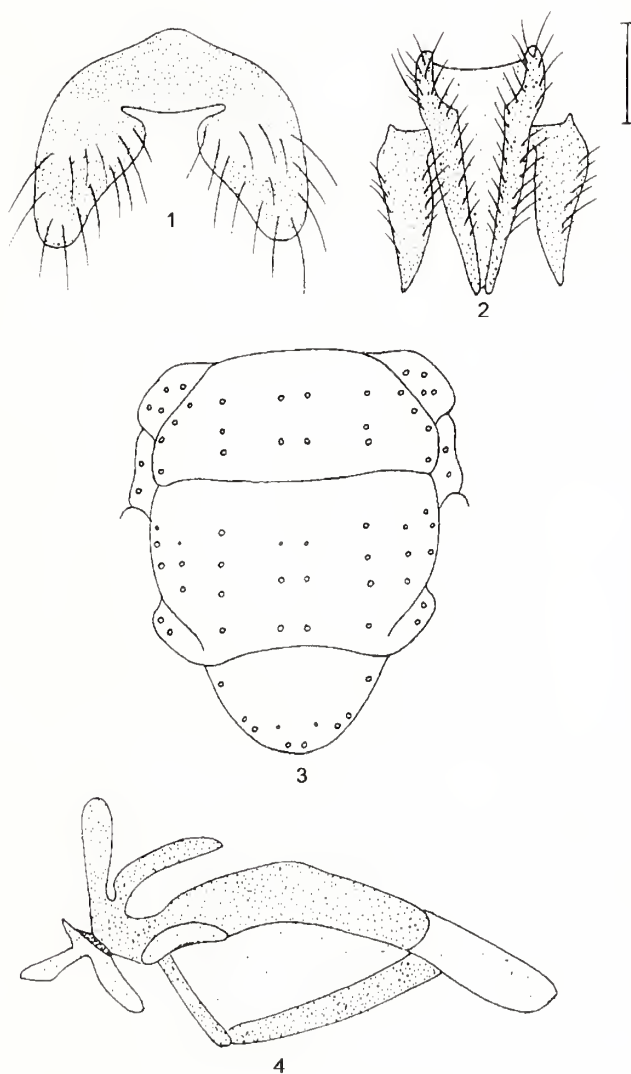
*Melinda chambaensis* sp. nov.

(Figs 1-4)

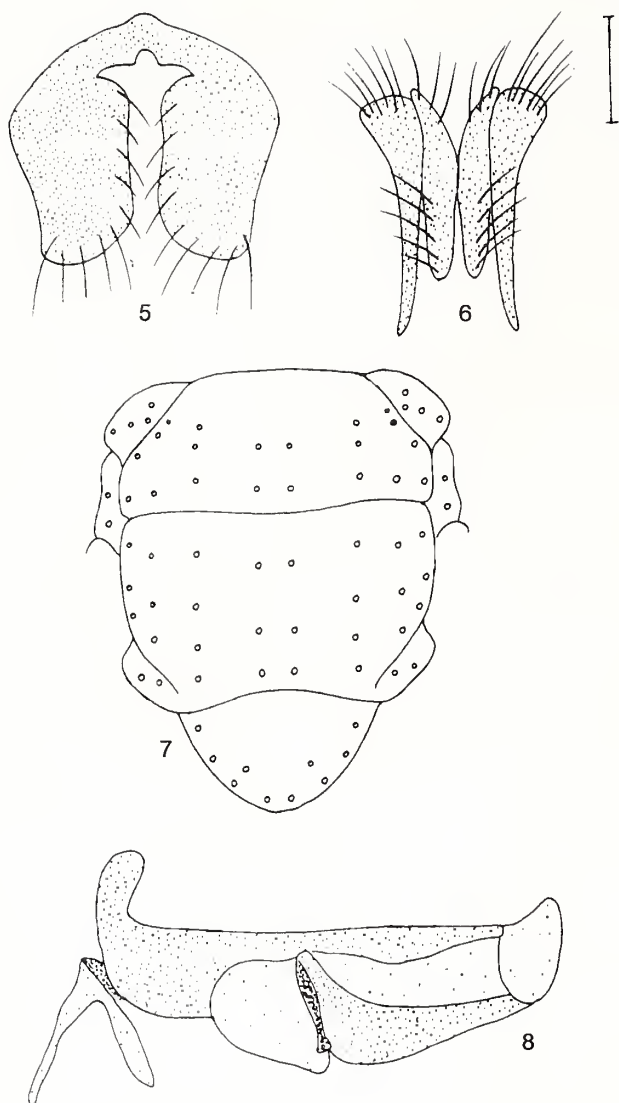
**Male:** Body length 13.0-13.5 mm.

**Head:** Eyes bare, subholoptic, facets uniform; ptilinal angle strongly projecting; frons dark brown, triangular, gets narrow as it approaches vertex; parafrontalia greyish, narrower than frons; frontal bristles well developed; fronto-orbital bristles absent; ocellus with weak ocellar bristles and strong postvertical bristles; vertical bristles weak, prevertical and outervertical bristles absent; parafacialia and face greyish with silver tinge; facial carina very strong; epistome grey; medianae and jowls dark brown, golden dusted, hairy; genae and postgenae greyish black with black and golden hair; vibrissae present just above oral margin; persitomal bristles well-developed; postorbit golden with golden tomentum; occiput greyish, covered with golden and black hair; 1st antennal segment brown, 2nd segment dark brown with black setulae, 3rd segment black and its length only 1.5x that of 2nd; arista black, long plumose; palpi black with bristles present all over.

**Thorax:** Black, strongly golden dusted with dark

Figs. 1-4: *Melinda chambaensis* sp. nov.

1. Fifth sternite of male (Magnification line = 0.5 mm);
2. Cerci and paralobi (Magnification line = 0.25 mm);
3. Dorsal view of chaetotaxy of thorax (Diagramatic);
4. Aedeagus and parameres (Magnification line = 0.17 mm)



Figs. 5-8: *Melinda chandigarhensis* sp. nov.

5. Fifth sternite of male (Magnification line = 0.4 mm);

6. Cerci and parolobi (Magnification line = 0.29 mm);

7. Dorsal view of chaetotaxy of thorax (Diagramatic);

8. Aedeagus and parameres (Magnification line = 0.15 mm)

longitudinal stripes beyond transverse suture; humerus golden dusted; postalar callus brown with golden dusting; prothoracic spiracle brown; propleuron greyish with golden dusting, hairy; prosternum hairy; post-alar declivity bare; supraspiracular convexity bare; suprasquamal ridge with anterior tuft.

**Chaetotaxy** (Fig. 3): Acrostichals 2+3; dorsocentrals 3+4; intra-alars 0+3; presutural present; humerals 4; posthumeral 3; supra-alars 3; post-alars 2; notopleurals 2; lateroscutellars 3; apicoscutellar and discoscutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

**Wings:** Hyaline, with yellowish tinge; veins brown; stem vein (R) bare;  $R_1$  bare;  $R_{4+5}$  black, setulose at basal node on

both dorsal and ventral sides; first posterior cell ( $R_5$ ) open; epaulet and basicosta black; alar and thoracic squamae brownish yellow; thoracic squama rounded at apex with soft white hair at margin while bare dorsally; halteres yellow.

**Legs:** Black; fore- and hind-femora with bristles on both dorsal and ventral sides while mid-femur with bristles on dorsal side only; fore- and mid-tibiae with two bristles at middle and three at apex; hind-tibia with two bristles at middle and one at apex.

**Abdomen:** Black patched with golden dusting; tergite 2 darker than others, tergites 2 and 3 with weak marginal bristles present at lateral side, tergites 4 and 5 with strong marginal bristles; sternites 1-5 with long black hairs.

**Genitalia:** Fifth sternite (Fig. 1), Cerci and parolobi (Fig. 2), Aedeagus and parameres (Fig. 4).

**Female:** Unknown.

**Holotype:** Male, Himachal Pradesh: Chamba-996M, 22.ix.2000, Coll. Inderpal Singh Sidhu.

**Paratypes:** (2♂♂) Himachal Pradesh: Chamba-996M (1♂) 21.ix.2000; Kandi -2355M (1♂) 14.ix.2000. Coll. Inderpal Singh Sidhu.

**Distribution:** Himachal Pradesh, India.

**Remarks:** This new species is closely related to *M. pusilla pusilla* (Villeneuve). However, it is separated from the latter on the basis of following combination of characters: frons dark brown (orange in *pusilla pusilla*); antennae and palpi dark brown to black (orange in *pusilla pusilla*); first posterior cell ( $R_5$ ) open (closed in *pusilla pusilla*); basicosta black (yellow in *pusilla pusilla*); legs black (testaceous in *pusilla pusilla*).

**Etymology:** The species name has been derived from the name of the type locality.

*Melinda chandigarhensis* sp. nov.

(Figs 5-8)

**Male:** Body length 7.5 mm

**Head:** Eyes hairy, subholoptic, facets uniform; ptilinal angle strongly projecting; frons reddish brown, narrower than parafrontalia; parafrontalia brownish, hairy; frontal bristles well-developed; fronto-orbital bristles absent; ocellus with weak ocellar and postvertical bristles; vertical and outervertical bristles absent, prevertical bristles present; parafacialia orange with brownish tomentum, bare; face brownish; facial carina present; epistome yellowish; medianae reddish brown, bare; jowls and genae greyish brown with black hair; postgenae brownish, with intermixed black and pale hair; vibrissae present well above oral margin; peristomal bristles well-developed; postorbit greyish with golden tomentum, bare; occiput greyish, covered with black and

pale hair; antennae dark brown, length of 3rd segment about 4.5x that of 2nd; arista brown, long plumose; palpi black with bristles present all over.

**Thorax:** Shining black with purplish tinge, with dark longitudinal stripes; humerus concolorous with dorsum; postalar callus brown; prothoracic spiracle brown; propleuron and prosternum bare at centre and hairy at margins; postalar declivity and supraspiracular convexity bare; suprasquamal ridge with anterior tuft.

**Chaetotaxy** (Fig. 7): Acrostichals 2+3; dorsocentrals 3+4; intra-alars 1+3; presutural present; humerals 4; posthumeral 3; supra-alars 3; post-alars 2; notopleurals 2; lateroscutellars 3; apicoscutellar and discoscutellar 1 each; sternopleurals 2+1; propleural and prostigmatic present.

**Wings:** Hyaline; veins brown; stem vein (R) bare;  $R_1$  bare;  $R_{4+5}$ , setulose at base on both dorsal and ventral sides; first posterior cell ( $R_5$ ) open; epaulet and basicosta brown; subcostal sclerite with fine pubescence; alar and thoracic squamae dirty yellow, bare, with yellow marginal cilia; both squamae bare on dorsal surface; halteres brown.

**Legs:** Brownish; fore- and hind-femora with bristles on both dorsal and ventral sides and mid-femur with bristles on ventral side only; tibiae with series of bristles.

**Abdomen:** Tergites 2 and 3 light brown, black in middle, with decumbent marginal bristles; tergites 4 and 5 dark brown with series of strong marginal bristles; sternites 1-5 with long black hair.

**Genitalia:** Fifth sternite (Fig. 5), Cerci and parolobi (Fig. 6), Aedeagus and parameres (Fig. 8)

**Female:** Unknown.

**Holotype:** Male, Chandigarh-300M 20.viii.2002. Coll. Inderpal Singh Sidhu.

**Distribution:** Chandigarh, India.

**Remarks:** Because of hairy eyes, this new species comes near *M. abdominalis* Malloch and *M. scutellata* Senior-White. It can be separated from *M. abdominalis* by the following combination of characters: parafrontalia and face brownish without dusting (with silver grey dusting in *abdominalis*); palpi black (yellow in *abdominalis*); antennae dark brown (reddish in *abdominalis*); postalar declivity bare

(setulose in *abdominalis*). The following characters separate it from *M. scutellata*: facial carina present (absent in *scutellata*); pitilinal angle strongly projecting (not projecting in *scutellata*); antennae dark brown (orange in *scutellata*); length of 3rd antennal segment 4.5x that of 2nd (3x in *scutellata*); dorsocentrals 3+4 (2+3 in *scutellata*); humerals 4 (3 in *scutellata*); posthumeral 3 (2 in *scutellata*); post alar declivity bare (hairy in *scutellata*); basicosta brown (yellow in *scutellata*); squamae yellow (dark brown in *scutellata*).

**Etymology:** The name of this species has been derived from the type locality.

#### KEY TO THE INDIAN SPECIES OF GENUS *MELINDA*

1. Eyes hairy; legs orange to brownish; epaulet and basicosta yellowish to brown; facial carina absent or weak ..... 2
- Eyes bare; legs black; epaulet and basicosta black; facial carina very strong ..... *M. chambaensis* sp. nov.
2. Presutural intra-alar present; length of 3<sup>rd</sup> antennal segment at least 3x that of 2<sup>nd</sup>; sternopleural hair black; first posterior cell ( $R_5$ ) open ..... 3
- Presutural intra-alar absent; length of 3<sup>rd</sup> antennal segment 2x that of 2<sup>nd</sup>; sternopleural hair yellowish; first posterior cell ( $R_5$ ) closed ..... *M. pusilla indica* (Kurahashi)
3. Facial carina absent; pitilinal angle not projecting; length of 3<sup>rd</sup> antennal segment 3x that of 2<sup>nd</sup>; dorsocentrals 2+3; humerals 3; post-alar declivity hairy ..... 4
- Facial carina present; pitilinal angle strongly projecting; length of 3<sup>rd</sup> antennal segment 4.5x that of 2<sup>nd</sup>; dorsocentrals 3+4; humerals 4; post-alar declivity bare ..... *M. chandigarhensis* sp. nov.
4. Posthumeral 3; palpi yellow; scutellum entirely yellow; tergites 2-3 yellow with brownish hind margins; squamae orange ..... *M. abdominalis* Malloch
- Posthumeral 2; palpi orange; scutellum black with apex yellow; tergites 2-3 greyish black; squamae dark brown ..... *M. scutellata* Senior-White

#### ACKNOWLEDGEMENTS

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CRAB SPIDERS (ARANEAE: THOMISIDAE) OF JALDAPARA WILDLIFE SANCTUARY, JALPAIGURI, WEST BENGAL - I<sup>1</sup>SUMANA SAHA<sup>2,3</sup> AND DINENDRA RAYCHAUDHURI<sup>2,4</sup><sup>1</sup>Accepted April 06, 2005<sup>2</sup>Entomology Laboratory, Department of Zoology, University of Calcutta, 35, Ballygunge Circular Road, Kolkata 700 019, West Bengal, India.<sup>3</sup>Email: sumu17@rediffmail.com<sup>4</sup>Email: dinendrar@rediffmail.com, dinendrar@yahoo.co.in

The paper deals with the thomisid spiders recorded so far from the Jaldapara Wildlife Sanctuary. Of these, *Camaricus* (*Indocamaricus*) *siltorsus* and *Xysticus bengdakis* are considered as new taxa. Hitherto unknown male morphs of *Misumena nicobarensis* Tikader and *Pistius kalimpus* Tikader have also been recorded. Six species, namely *Camaricus khandalaensis* Tikader, *Misumena nicobarensis* Tikader, *Pistius barchensis* Basu, *P. gangulyi* Basu, *P. roonwali* Basu and *P. sreepauchanii* Tikader, are identified as new for the state of West Bengal and one, *Thomisus bulani* Tikader, for the district.

**Key words:** Thomisid spiders, new subgenus, new species, new morph, new record, Jaldapara Wildlife Sanctuary, Jalpaiguri, West Bengal

## INTRODUCTION

Thomisid spiders of West Bengal, so far, are known to belong to subfamilies Misumeninae and Philodrominae (Tikader 1980; Biswas and Biswas 1992). Misumeninae is represented by 25 species under nine genera and Philodrominae by three species under two genera (Biswas and Biswas 1992; Saha and Raychaudhuri (2004). Philodrominae is now considered as a distinct family (Platnick 2003).

This paper deals with 11 thomisid spider species (Misumeninae) belonging to the genera *Camaricus* Thorell, *Xysticus* Koch, *Misumena* Latreille, *Pistius* Simon and *Thomisus* Walckenaer recorded from Jaldapara Wildlife Sanctuary. Of these, two species each of *Camaricus* and *Xysticus* are considered new, and accordingly described and illustrated. The *Camaricus* species is accommodated under a new subgenus. Further, hitherto unknown morphs of *Misumena nicobarensis* Tikader and *Pistius kalimpus* Tikader are also described and illustrated.

The specimens have been deposited in the collection of Entomology Laboratory, Department of Zoology, University of Calcutta.

## MATERIAL AND METHODS

Collection and preservation of the spider samples was carried out following Tikader (1987). The materials were studied using a stereo zoom binocular microscope. All the measurements are in millimetres, made with an eyepiece graticule.

1. *Camaricus formosus* Thorell

*Camaricus formosus* Thorell 1887. Ann. Mus. civ. stor. Nat. Gen. 5(2): 261.

**Material examined:** 1 ♂ ♀, Jaldapara, 7.iii.2002; 2 ♀, Moiradanga, 7.iii.2002; 3 ♀ ♀, DDG, 25.iii.2002; 3 ♀ ♀, Sissamara, 25.iv.2002; 1 ♀, TEC, 26.iv.2002; 4 ♀ ♀, Bengdaki, 27.iv.2002; 1 ♀, Kunjanagar, 27.iv.2002; 7 ♀ ♀, Hollong, 29.iv.2002; 3 ♀ ♀, Bania, 8.vi.2002; 2 ♀ ♀, 4 ♂ ♂, Chilapata, 8.vi.2002; 4 ♀ ♀, 1 ♂, Celine, 9.vi.2002; 2 ♀ ♀, Mendabari, Jaldapara Wildlife Sanctuary, Jalpaiguri, 9.vi.2002.

**Distribution:** INDIA: Andaman Islands, Karnataka, Maharashtra, West Bengal (Tikader 1980; Biswas and Biswas 1992; Platnick 2003); Bangladesh; China; Indonesia; Myanmar; Philippines; Sumatra (Tikader 1980; Platnick 2003).

2. *Camaricus khandalaensis* Tikader

*Camaricus khandalaensis* Tikader 1980. Fauna of India: Araneae: Spiders. Vol. 1, Pt. I Thomisidae: 177-178.

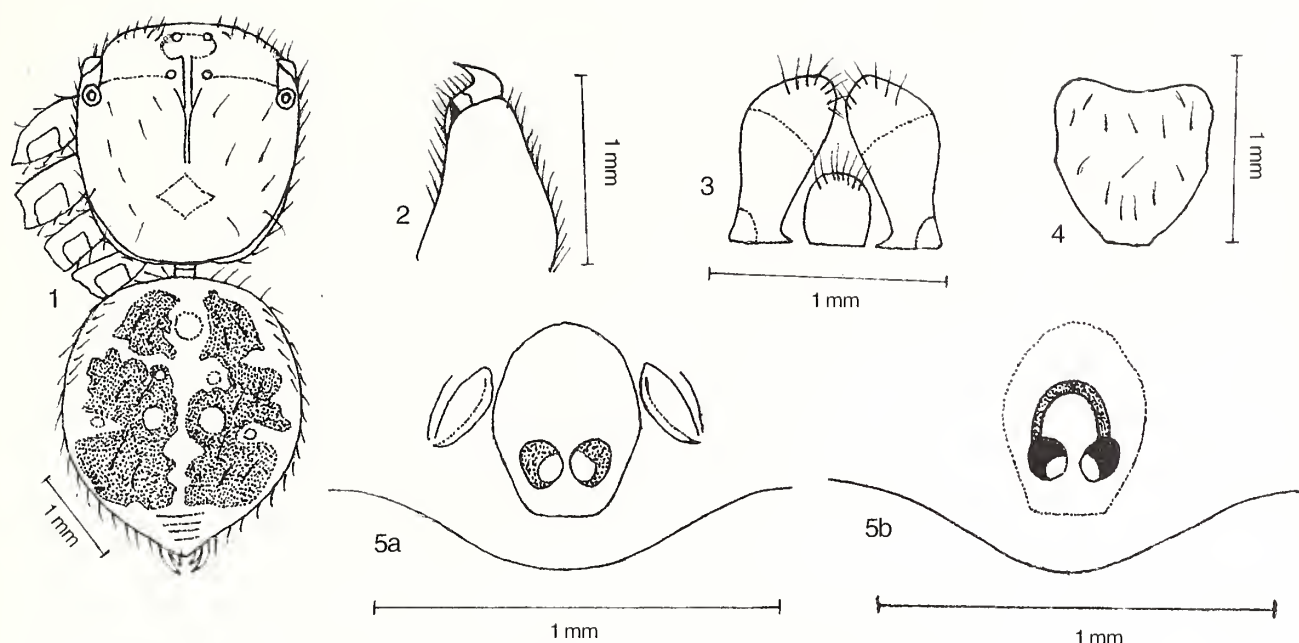
**Material examined:** 1 ♀, TEC, 26.4.2002; 1 ♀, Mendabari, 9.6.2002; 2 ♀ ♀, Celine, Jaldapara Wildlife Sanctuary, Jalpaiguri, 9.6.2002.

**Distribution:** INDIA: (Platnick 2003): Maharashtra (Tikader 1980), West Bengal (new record).

3. *Camaricus* (*Indocamaricus*) *siltorsus* n. gen. et sp. n. (Figs 1-5)

**Female:** Holotype: Total length 5.77; carapace length 2.58, width 2.38; abdomen length 3.00, width 2.54; legs as in Table 1.

Cephalothorax (Fig. 1) dark reddish brown, longer than wide, front wide, parallel-sided, thoracic region marginally



Figs 1-5: *Camaricus (Indocamaricus) siltorsus* n. gen. et. sp. n., female holotype  
1. Whole body, 2. Chelicerae, 3. Maxillae and labium, 4. Sternum, 5a. Epigynum, 5b. Internal genitalia

slightly laminate, medially slightly raised, clothed with dense black hairs; eyes transparent, in two rows, both rows recurved, laterals contiguous, eyes of anterior row basally ringed with black band, posteromedians smallest, ocular quad squarish, posteriorly wide; chelicerae (Fig. 2) reddish brown, robust, inner margin only with single tooth, fangs yellowish red, small, weakly curved; maxillae and labium (Fig. 3) brown, apically whitish, both elongate and anteriorly scopulate; sternum (Fig. 4) brown, heart-shaped, anterior margin concave, posteriorly truncate, with hairs; legs yellow, segments distally with brown band, robust, clothed with hairs and spines, femora distally with black patch, tibiae and metatarsi I & II provided with 3 pairs of ventral spines, leg formula 2341. Abdomen yellow with black patch (Fig. 1), medially with 5 brown sigilla, longer than wide, oval, widest behind the middle, clothed with black hairs; venter black with mid-longitudinal broad whitish band extending from epigastric furrow to near the base of spinnerets, with few brown sigilla, epigyne and internal genitalia (Figs 5a & 5b).

**Material examined:** Holotype: ♀, Siltorsa, 7.vi.2002;

Coll. S. Bhattacharjee. Paratypes: 1 ♀, Sissamara, 23.iii.2002; 2 ♀ ♀, Moiradanga, 27.iii.2002; 1 ♀, Siltorsa, 24.iv.2002; 1 ♀ ♀, Hollong, Jaldapara Wildlife Sanctuary, Jalpaiguri, 29.iv.2002 (Regn. No. EZC 0005-03).

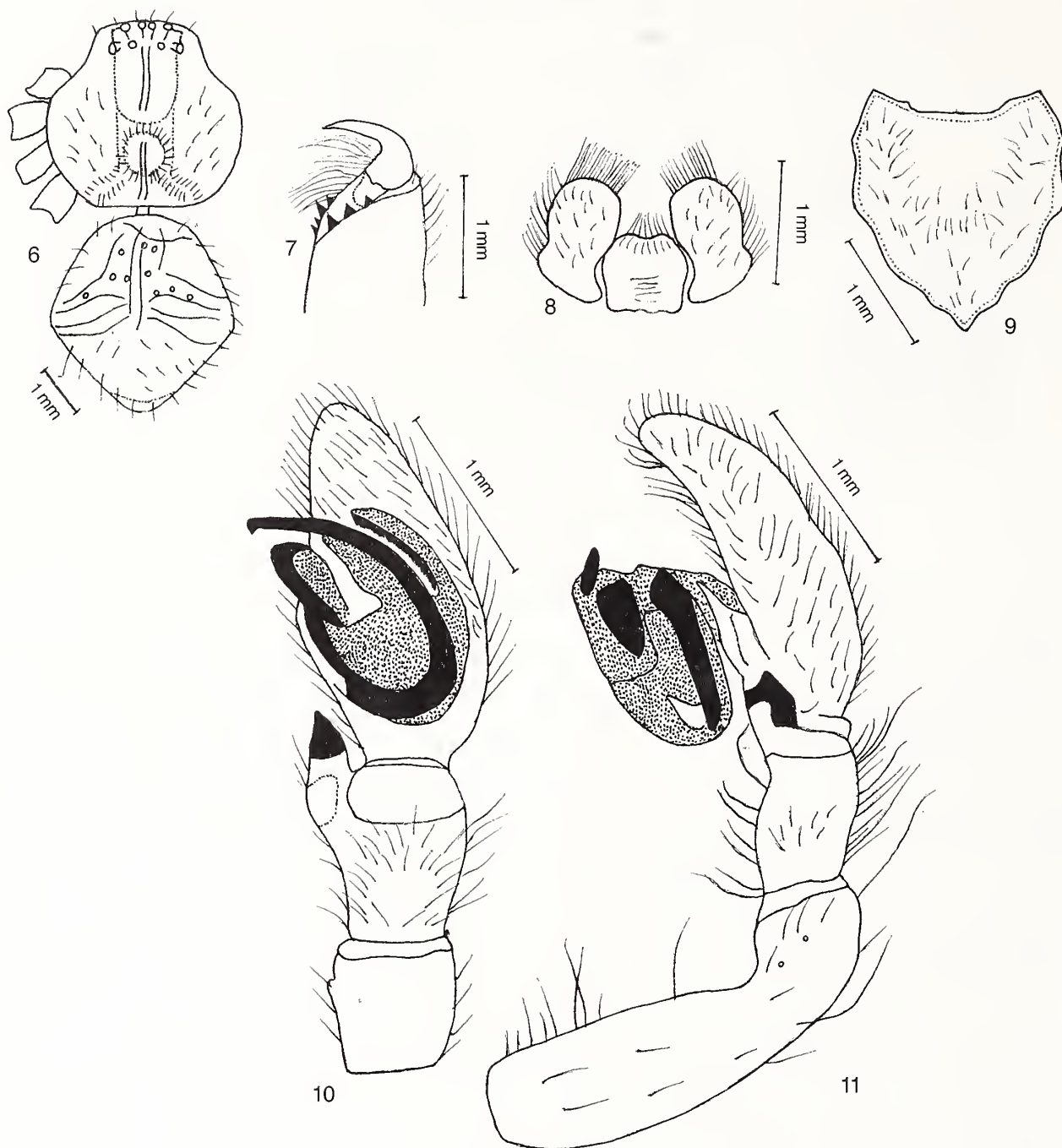
**Distribution:** INDIA: West Bengal.

**Etymology:** The sub-generic and specific names are derived from the names of the country and type locality respectively.

**Discussion:** As the middle eyes of the present species are closer to each other than to the laterals it does not seem to be an ally of *Camaricus* Thorell s. str. However, following the key to the Indian species (Tikader 1980) of *Camaricus* Thorell, the taxon may at best be related to *Camaricus formosus* Thorell because of the general pattern and somewhat similar coloration. The other diagnostic features that support its distinction are: marginally laminate thoracic region, cheliceral inner margin with single tooth, apically blunt sternum, sigilla on abdomen, leg formula 2341 and widely distant epigyne and internal genitalia. Therefore, the present species is considered as new to science.

**Table 1:** Length of legs of ♀ holotype of *Camaricus (Indocamaricus) siltorsus* n. gen. et. sp. n. (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	0.86/0.86	1.57/1.57	2.43/2.43	1.29/1.30	1.71/1.70	7.86/7.86
II	1.29/1.29	1.57/1.57	2.71/2.71	1.57/1.58	2.14/2.15	9.28/9.30
III	1.14/1.15	1.57/1.57	2.57/2.58	1.42/1.43	1.86/1.85	8.56/8.58
IV	1.14/1.14	1.57/1.57	2.71/2.71	1.28/1.29	1.71/1.70	8.41/8.41

Figs 6-11: *Misumena nicobarensis* Tikader, male

6. Whole body, 7. Chelicerae, 8. Maxillae and labium 9. Sternum, 10. Male palp (ventral view), 11. Male palp (lateral view)

4. *Misumena*<sup>#</sup> *nicobarensis* Tikader

(Figs 6-11)

*Misumena nicobarensis* Tikader 1980. Fauna of India, Spiders. Thomisidae 1(1): 102.

**Male:** Measurements (in mm): Total length 7.53; carapace length 3.58, width 3.74; abdomen length 3.74, width 3.47; legs as in Table 2.

Cephalothorax (Fig. 6) brown black, little wider than long,

cephalic region narrower, medially lighter and raised, mid-longitudinally with narrow parallel dark brown lines, those on the thoracic region short, thoracic region medially foveolate, clothed with dense white pubescence; eyes pearly white, in two rows, anterior row more recurved than the posterior row, anterior eyes nearly equidistant, posteromedians smallest, ocular quad rectangular, longer than wide; chelicerae (Fig. 7) dark brown black, robust, inner margin with 3 and outer margin



**Table 2:** Length of legs of ♂ of *Misumena nicobarensis* Tikader (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	5.45/5.44	1.82/1.81	5.09/5.08	2.91/2.91	1.82/1.82	17.09/17.06
II	4.55/4.55	1.80/1.80	4.90/4.91	2.73/2.74	1.64/1.63	15.62/15.63
III	2.55/2.56	1.45/1.45	2.18/2.18	0.73/0.74	1.27/1.28	8.18/8.21
IV	3.27/3.28	1.45/1.45	2.55/2.54	2.18/2.18	1.45/1.44	10.90/10.89

with 4 teeth, with long hairs, fangs reddish, small, weakly curved; maxillae and labium (Fig. 8) brownish black, maxillae robust, apically broad, anteriorly scopulate, labium almost square, constricted before middle, anteriorly scopulate; sternum (Fig. 9) reddish, typically heart-shaped, anterior margin concave, posteriorly narrowing, with hairs; legs brown, femora and patella I & II brownish black, tibiae and metatarsi I & II with 4 and 3 pairs of ventral spines respectively, with hairs black, set on black sockets, leg formula 1243.

Abdomen (Fig. 6) brownish with black patches, pentagonal, little longer than wide, medially broadest, anteriorly little concave, posteriorly narrowed. Venter uniformly pale brown. Male palp as in Figs 10 & 11.

**Material examined:** 2 ♀ ♀/2 ♀ ♀, Jaldapara, 7.iii.2002/27.iii.2002; 5 ♀ ♀, Malangi, 7.iii.2002; 1 ♂/1 ♀/1 ♀ Sissamara, 23.iii.2002/25.iii.2002; 2 ♀ ♀, DDG, 25.iii.2002; 1 ♀, Kunjanagar, 15.iii.2002; 4 ♀ ♀, TEC, 26.iii.2002; 7 ♀ ♀, Moiradanga, 27.iii.2002; 1 ♀, Chilapata, Jaldapara Wildlife Sanctuary, Jalpaiguri, 8.vi.2002.

**Distribution:** INDIA: Nicobar Islands (Tikader 1980; Platnick 2002), West Bengal (#new record).

### 5. *Pistius barchensis* Basu

*Pistius barchensis* Basu 1965. Proc. zool. Soc., Calcutta 18: 74.

**Material examined:** 1 ♀, Bania, Jaldapara Wildlife Sanctuary, Jalpaiguri, 8.6.2002.

**Distribution:** INDIA: Uttar Pradesh (Tikader 1980; Platnick 2003), West Bengal (new record).

### 6. *Pistius kalimpus* Tikader

(Figs 12-15)

*Pistius kalimpus* Tikader 1970. Rec. Zool. Surv. India, Calcutta 64: 58.

**Male:** Measurements (in mm): Total length 6.08; carapace length 2.88, width 2.77; abdomen length 3.19, width 2.77; legs as in Table 3.

Cephalothorax (Fig. 12) pale yellow with green spots, each with a pale brown hair, almost as long as wide, oval, somewhat narrow in front, clypeus high, obtuse, margin provided with moderately long hairs; eyes black, set on white tubercles, in two rows; anterior row more strongly recurved than posterior row, ocular quad nearly as long as wide, anteromedians slightly closer than posteromedians, laterals larger, contiguous; chelicerae (Fig. 13) pale yellow, dorsally with green spots, robust, inner margins devoid of any tooth, outer margin with 7 minute denticles extending throughout the length, fangs light brown, small, weakly curved; maxillae and labium (Fig. 14) pale yellow, both elongate, scopulate; sternum (Fig. 15) pale yellow, heart-shaped, anterior margin straight, with very few hairs; legs pale yellow, tibiae and metatarsi I and II ventrally armed with 4 and 6 pairs of spines respectively, leg formula 1234.

Abdomen (Fig. 12) pale with chalk white patches, mixed with black tint, longer than wide, oval, anteriorly straight, posteriorly rather blunt, with brown small erect hairs arising from brown sockets; venter pale medially darker. Male palp not developed fully, therefore not illustrated.

**Material examined:** 1 ♂, Bania, Jaldapara Wildlife Sanctuary, Jalpaiguri, coll. S. Bhattacharjee, 8.vi.2002; 3 ♂ ♂ (immature), Chilapata, Jaldapara Wildlife Sanctuary, Jalpaiguri, 8.vi.2002.

**Distribution:** INDIA: West Bengal (Tikader 1980; Platnick 2003).

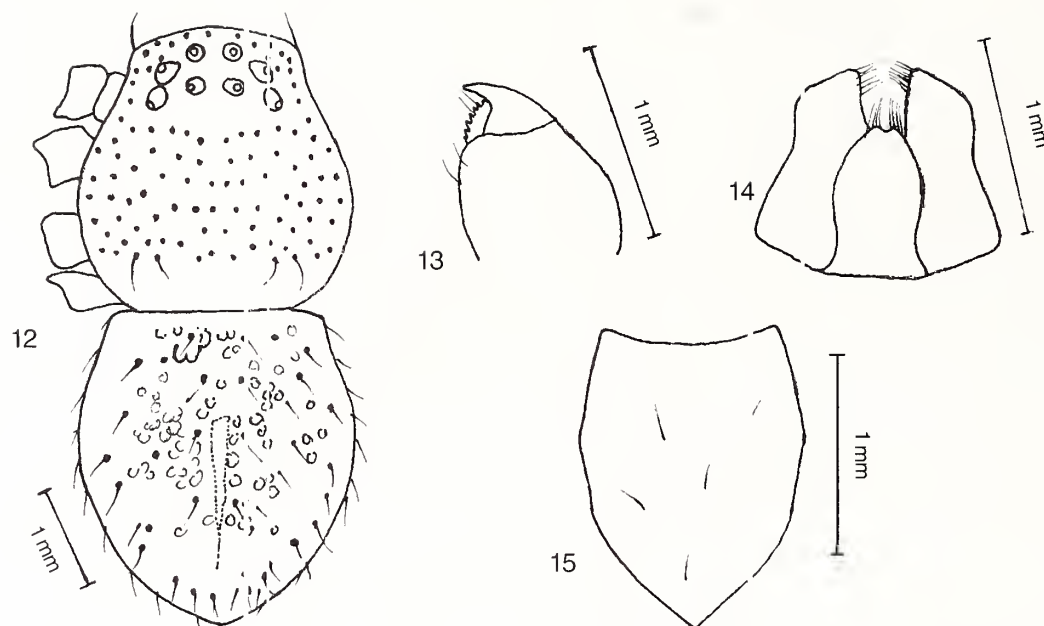
### 7. *Pistius gangulyi* Basu

*Pistius gangulyi* Basu 1965. Proc. Zool. Soc., Calcutta 18: 73.

**Material examined:** 1 ♀, Bengdaki, 8.xi.2001; 1 ♀,

**Table 3:** Length of legs of ♀ *Pistius kalimpus* Tikader (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	2.86/2.86	1.29/1.28	1.86/1.85	1.57/1.56	1.14/1.15	8.72/8.70
II	2.43/2.43	1.14/1.14	2.00/2.00	1.57/1.57	1.14/1.14	8.28/8.28
III	1.43/1.44	0.71/0.70	1.00/1.01	0.71/0.70	0.71/0.70	4.56/4.55
IV	0.86/0.86	0.71/0.71	1.14/1.14	0.71/0.70	0.71/0.71	4.13/4.12



Figs 12-15: *Pistius kalimpus* Tikader, male  
12. Whole body, 13. Chelicerae, 14. Maxillae and labium, 15. Sternum

Moiradanga, Jaldapara Wildlife Sanctuary, Jalpaiguri, 9.xi.2001.

**Distribution:** INDIA: Uttar Pradesh (Tikader 1980; Platnick 2003), West Bengal (new record); China (Platnick 2003).

#### 8. *Pistius roonwali* Basu

*Pistius roonwali* Basu 1964. J. Bengal nat. Hist. Soc., Darjeeling 32 (2): 104.

**Material examined:** 1 ♂, Bania, Jaldapara Wildlife Sanctuary, Jalpaiguri, 7.vi.2002.

**Distribution:** INDIA: Uttar Pradesh (Tikader 1980; Platnick 2003), West Bengal (new record).

#### 9. *Pistius sreepauchanii* Tikader

*Pistius sreepauchanii* Tikader 1971. Mem. zool. Surv. India 15(3): 30.

**Material examined:** 1 ♂, Bania, Jaldapara Wildlife Sanctuary, Jalpaiguri, 8.vi.2002.

**Distribution:** INDIA: Meghalaya (Tikader 1980; Platnick 2003), West Bengal (new record).

#### 10. *Thomisus bulani* Tikader

*Thomisus bulani* Tikader 1960. J. Bombay Nat. Hist.

Soc. 57(1): 178.

**Material examined:** 1 ♀, Malangi, Jaldapara Wildlife Sanctuary, Jalpaiguri, 23.iii.2002.

**Distribution:** INDIA: West Bengal (Tikader 1980; Platnick 2003) (dist. Jalpaiguri – new record).

#### 11. *Xysticus bengdakus* sp. nov.

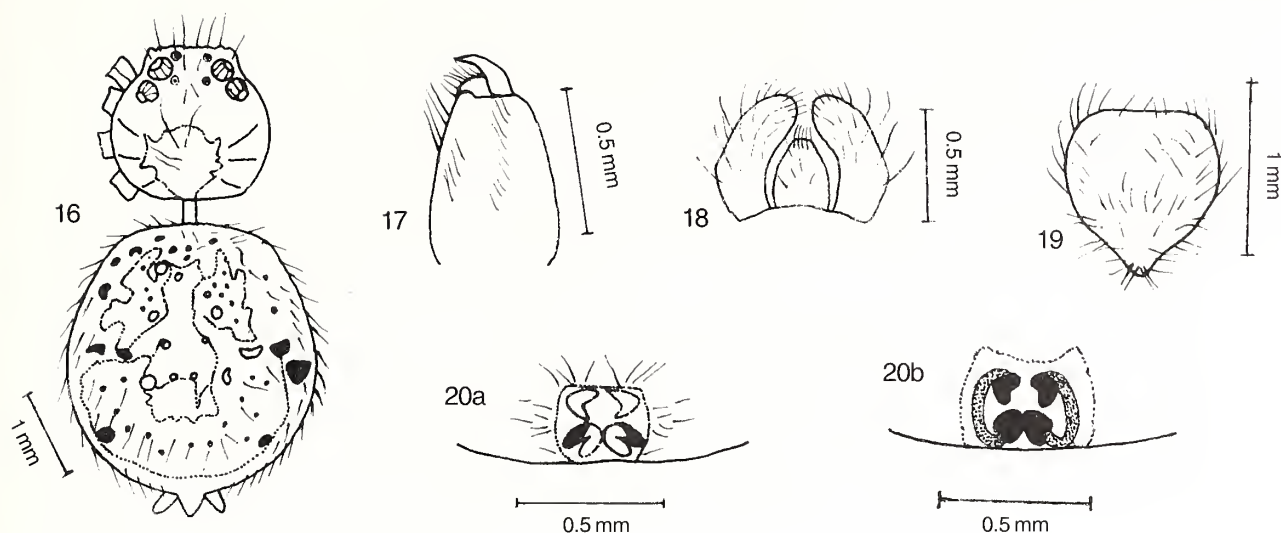
(Figs 16-20)

**Female (Holotype):** Total length 5.42; carapace length 1.77, width 1.77; abdomen length 3.35, width 2.85; legs as in Table 4.

Cephalothorax (Fig. 16): Brown, medially pale, as long as wide, cephalic region high, clothed with few long black hairs; clypeus high, vertical, edge marked by 6 long brown spines, eyes black situated on tubercles, in two rows, both rows strongly recurved, laterals contiguous, ocular quad squarish, slightly longer than wide, with 2 moderately long black hairs, anteromedians closer to laterals than to each other; chelicerae (Fig. 17) light yellow, robust, margins devoid of any tooth, fangs yellow, small, weakly curved; maxillae and labium (Fig. 18) light yellow, small, elongate, anteriorly

**Table 4:** Length of legs of ♀ holotype of *Xysticus bengdakus* sp.n. (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	1.71/1.72	0.71/0.71	1.71/1.70	1.43/1.43	1.00/1.00	6.56/6.56
II	2.57/2.57	0.71/0.71	2.00/2.00	1.14/1.15	1.00/1.01	7.42/7.44
III	1.57/1.58	0.71/0.71	0.57/0.58	1.00/1.00	1.00/1.00	4.85/4.87
IV	1.43/1.42	0.57/0.57	1.29/1.28	0.86/0.85	1.00/1.00	5.15/5.12

Figs 16-20: *Xysticus bengdakus* sp. n., female holotype

16. Whole body, 17. Chelicerae, 18. Maxillae and labium, 19. Sternum, 20a. Epigynum, 20b. Internal genitalia

scopulate; sternum (Fig. 19) light yellow, typically heart shaped, with hairs; legs light yellow, moderately elongate, tibiae I and II with 2 pairs of ventral spines, leg formula 2143.

Abdomen (Fig. 16) light yellow, with scattered patches of black, chalk white and also brown small sigilla, globose, with black hairs; venter pale yellow, laterally margined by black patches, epigyne and internal genitalia as in Figs 20a & 20b.

**Material examined:** Holotype: 1 ♀, Bengdaki, Jaldapara Wildlife Sanctuary, Jalpaiguri, West Bengal, India, Coll. S. Bhattacharjee, 8.11.2001 (Regn. No. EZC 0006-03).

**Distribution:** INDIA: West Bengal (known only from the type locality).

**Etymology:** Species name is derived from the type locality.

**Remark:** The present species with a pale median area

on cephalothorax and 6 strong forwardly directed spines on clypeus shows a close affinity to *Xysticus kamakhya* Tikader but, is distinct in having anteromedian eyes close to anterolaterals, laterals closely apposed, sternum heart-shaped, very different abdominal decoration, sigilla and epigyne. The species is therefore recognized as new to science.

#### ACKNOWLEDGEMENTS

We are thankful to the University Grants Commission, New Delhi for financial assistance (Project Sanction No. F: 3-136/2001 (SR-II) dt. 28.3.2001 & dt. 20.4.2001), the authorities of Jaldapara Wildlife Sanctuary, West Bengal, and the Head, Department of Zoology, University of Calcutta, for kindly providing the necessary facilities.

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# A NEW SPECIES OF NAMANEREIDINAE: *NAMALYCASTIS GLASBYI* SP. NOV. FROM INDIAN WATERS<sup>1</sup>

OLIVIA J. FERNANDO<sup>2,3</sup> AND R. RAJASEKARAN<sup>2,4</sup>

<sup>1</sup>Accepted July 05, 2005

<sup>2</sup>Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai 608 502, Tamil Nadu, India.

<sup>3</sup>Email: cdl\_aucasmb@sancharnet.in, olivia\_cas@yahoo.com

<sup>4</sup>Email: sekar\_10677@yahoo.co.in

A new species of the Genera *Namalycastis*, Subfamily Namanereidinae, Family Nereidae, is being described here. Collections from Gorai creek, Mumbai, included Nereid worms previously undescribed. *Namalycastis indica* is a species of *Namalycastis* recorded most frequently from India. Subsequently *N. fauveli* has been described from Indian waters. In addition to this *N. abiuma* species group has also been observed though not recorded. As *N. indica* and *N. abiuma* resemble each other, there has been some confusion with regards to their occurrence from the different areas studied. The present study records the occurrence of a new species *Namalycastis glasbyi*; a key is being provided to help distinguish the different species of *Namalycastis* occurring in Indian waters.

**Key words:** Nereidae, *Namalycastis glasbyi* sp. nov., Mumbai, *Namalycastis indica*, *Namalycastis fauveli*

Hartman (1959) considered the genus *Lycastis* Savigny 1822 of the subfamily Namanereidinae as a synonym of *Nereis* Linnaeus 1758 and proposed the name *Namalycastis* to replace it. Characters used to distinguish genus *Namalycastis* are: presence of a mid-anterior cleft on the prostomium, two small conical antennae, two conspicuous, broad palps with distinct palpostyle, two pairs of tentacular cirri on either side in two bundles of two tentacles each, of which the longest reaches up to the fourth segment and absence of papillae and paragnaths in the pharynx. Dorsal cirri anteriorly slender and small, conical, posteriorly elongated, nearly one and a half times the length of the dorsal cirrus of the anterior segment. The reduced or lack of notopodial conditions of Namanereidinae is a unique feature among this group. The presence of both notoacacula and neuroacacula in the parapodia of the first two setigers is also unusual among the Nereididae.

The earliest record of this genus in India is by Southern (1921) from Chilika Lake as *Lycastis indica*. Since then, *Namalycastis indica* has been recorded from several estuaries, backwaters from the Andaman and Nicobar Islands and the east and west coast of India (Table 1). Southern (1921) also mentions two specimens collected from Cochin (now Kochi) backwaters and Garia, lower West Bengal, of which the single specimen from Cochin is described to have a single setae anterior to the dorsal aciculum and shorter antennae and tentacular cirri, thus differing from *Lycastis indica*. Glasby (1999) is of the opinion that this single specimen from Cochin, collected by Southern, may likely be another species, *N. abiuma* sp. group. Another species described from Bytarani estuary by Rao (1981) – *Namalycastis fauveli* – has also been frequently observed from several regions along the east coast of India. (Table 1)

**Table 1:** Records of distribution of *Namalycastis indica* and *N. fauveli* along the Indian coast

Sl. No	Reference	Study area	<i>N. indica</i>	<i>N. fauveli</i>
1.	Southern (1921)	Chilika Lake	X	
2.	Balasubrahmanyam (1960)	Vellar	X	
3.	Ghosh (1963)	Thiruchendur backwaters	X	
4.	Soota & Rao (1977)	Andaman & Nicobar islands	X	
5.	Rao (1981)	Bytarani estuary	X	X
6.	Srinivasa Rao & Rama Sarma (1981)	Vashista-Godavari	X	
7.	Antony and Kuttyamma (1983)	Vembanad estuary	X	
8.	Misra <i>et al.</i> (1984)	Gangetic delta	X	
9.	Misra and Choudhary (1985)	Sagar Island	X	
10.	Misra <i>et al.</i> (1987)	Orissa backwaters	X	
11.	Sunder Raj & Sanjeeva Raj (1987)	Pulicat	X	
12.	Kalaiselvi and Ayyakkannu (1986)	Vellar estuary	X	
13.	Rao (1993)	Mahanadi		X
14.	Rao (1995)	Chilika	X	X
15.	Misra (1995)	Hooghly Malta	X	X
16.	Rao (1998)	Bytarani estuary	X	X
17.	Rao (1999)	Godavari		X
18.	Rao (2001)	Godavari	X	X
19.	Pillai (2001)	Cochin backwater	X	

## MATERIAL AND METHODS

During the present study four specimens of the genus *Namalycastis* were collected from sandy, clayey intertidal

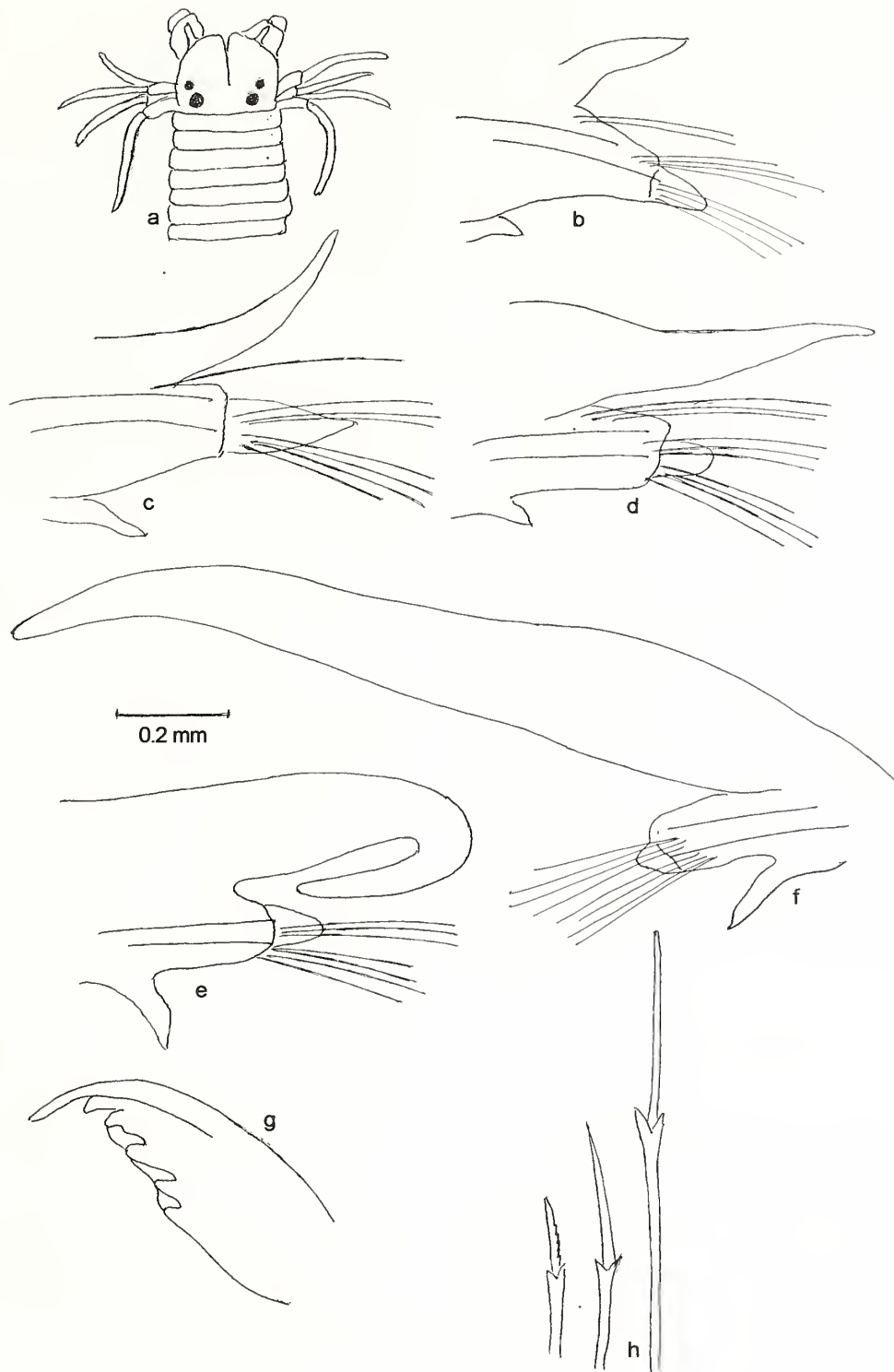


Fig. 1: *Nemalycastis glasbyi*: a. head; b. parapodia of segment 8; c. parapodia of segment 20; d. parapodia of segment 50; e. parapodia of segment 100; f. parapodia of segment 160; g. jaw piece, ventromedial view; h. neuropodial setae

sediments, about 3 km upstream in Gorai creek, Mumbai. Gorai creek situated in the suburbs of Mumbai (formerly Bombay) ( $19^{\circ} 12' N$ ,  $72^{\circ} 48' E$ ) extends 12 km inland through vast mangrove mudflats and low-lying marshy area. South of the

creek mouth, lies the Akse-Madh coastal strip; the northern bank of the creek is bordered by Manori village, which forms a natural beach. As these specimens were different from the species of *Nemalycastis* described earlier, more detailed

observations were made.

Three of the four specimens were complete; the largest had 289 segments up to 64 mm long and 1 mm wide. The longest tentacular cirri reached up to the fifth segment. Maximum width is at segment 15 after which it tapers gradually. The prostomium has a shallow cleft with a narrow longitudinal groove extending from tip to mid-posterior of prostomium. Eyes are in a straight line at the posterior margin of the prostomium and nearly coalescent. The proboscis is armed with a pair of jaws but lacks paragnaths and papillae. Each jaw has a distinct terminal tooth, a single subterminal tooth (Fig. 1g) and a group of four teeth ensheathed proximally. The presence of a single subterminal tooth distinguishes this specimen from all others of the *N. abiuma* sp. group.

The parapodia are sub-biramous, each carries two acicula. Neuropodial ligule bilobed with superior lobe papilliform and inferior lobe globular. Notopodial spiniger starts from setiger 4-6 and varies in number from 1-3, extending up to the 60<sup>th</sup> segment. Neurosetae are in two fascicles, one below and one above the ventral aciculum. The fascicle above the ventral aciculum (VA) has 8 spinigers and 5 falcigers; the fascicle below the VA has 3 spinigers and 8 falcigers.

Joint of the dorsal cirri with cirrophore is indistinct, posterior dorsal cirri nearly three and a half times as long as the parapodial lobe. The dorsal cirri increase in length posteriorly. On the anterior segment it is conical and only as long as the podium, almost double in length 50<sup>th</sup> segment onwards and nearly four times long at the 160<sup>th</sup> segment. At the posterior end the length is five times its width (Fig. 1a-h). Though there is no articulation, a slight constriction is present in the dorsal cirrus.

## DISCUSSION

*N. indica* and *N. abiuma* sp. group are similar in external appearance, and unless setal types and distribution are examined carefully the two species are very difficult to separate (Glasby 1999). Glasby is also of the opinion that most descriptions of *N. indica* in the taxonomic literature fail to give an adequate account of setal type distribution and therefore it is quite possible that the two species have been widely confused. Doubtful taxonomic reference to *N. indica* include those of Ghosh (1963), Day (1967) and Sunder Raj and Sanjeeva Raj (1987). As there is considerable difficulty in describing the distribution of setae, i.e. pre and post supra-acicular neurosetae, and the pre and post subacicular neurosetae, it is not surprising that there is considerable doubt

about earlier taxonomic references.

The present specimens differ from *N. indica* by presence of nearly coalescent eyes, unjointed dorsal cirrus that is elongated and enlarged in the posterior segments. It also differs from *N. fauveli* in which the anterior cleft is absent, the two pairs of eyes arranged transversely and presence of 2-3 subterminal teeth in the jaw. It differs from *N. abiuma* by the presence of notopodial setae (1-3) up to the mid body region, in no particular order, and by the presence of unequal number of heterogomph spinigers and falcigers in the neuropodia.

The presence of a single subterminal tooth in the jaw and the presence of notopodial setae ranging between 1 and 3 in the anterior part of the body distinctly separates these specimens from the previously described species and is therefore described here as a new species *Namalycastis glasbyi*.

## KEY TO DISTINGUISH GENUS *NAMALYCASTIS* OBSERVED FROM INDIAN WATERS

1. Acicular neuropodial ligule bilobed, superior lobe papilliform, inferior lobe globular ..... 2
- Acicular neuropodial ligule subconical or weakly bilobed ... 4
2. Antennae small, extending to tip of palpaphore ..... 3
- Antennae small, usually extending short of tip of palpaphore, jaw with 4-5 subterminal teeth & 3-5 ensheathed proximally  
*N. abiuma* sp. group
3. Jaw with 4 subterminal teeth, 4 ensheathed proximally ..... *N. abiuma*
- Jaw with 1 subterminal tooth and 4 ensheathed proximally ..... *N. glasbyi*
4. Jaw with 2-3 subterminal teeth, 2-4 ensheathed proximally, heterogomph falcigers with boss extremely prolonged ..... *N. fauveli*
- Jaw with 2-5 subterminal teeth, 3-5 ensheathed proximally, heterogomph falcigers with boss not prolonged ..... *N. indica*

**Habitat:** Holotype from a tidal creek nearly 3 km upstream, salinity unknown.

**Type locality:** Gorai creek, Mumbai, west coast of India.

**Etymology:** Named after Dr. Christopher J. Glasby for his detailed study of Namanereidinae.

## ACKNOWLEDGEMENT

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# ON THE DISCOVERY OF A NEW THRIPS RELATED TO THE GENUS *HAPLOTHRIPS* AMYOT & SERVILLE FROM DELHI<sup>1</sup>

VIKAS KUMAR<sup>2,3</sup>, KAOMUD TYAGI<sup>2,4</sup>, AND J.S. BHATTI<sup>2,5</sup>

<sup>1</sup>Accepted September 06, 2005

<sup>2</sup>Department of Zoology, University of Delhi, Delhi 110 007, India.

<sup>3</sup>Present address: Division of Entomology & Nematology, Indian Institute of Horticultural Research, Hessaraghatta, Lake Post, Bengalûru 560 089, Karnataka, India. Email: vikasnirwal@yahoo.com

<sup>4</sup>Present address: Insect Systematics Laboratory, Project Directorate of Biological Control, Bellary Road, Hebbal, Bengalûru 560 024, Karnataka, India. Email: ktyagi5@yahoo.com

<sup>5</sup>Email: jsbhatti@eth.in

A new genus and species of thrips, *Ahamothrips maxima*, collected from the monocot *Urochloa maxima* (Jack) R.D. Webster (Poaceae) have been described. The new genus is related to the genus *Haplothrips* except for the absence of ectoentarcine pseudunguis on the mid and hind tarsi.

**Key words:** *Ahamothrips maxima*, new genus and species, Phlaeothripidae, *Urochloa maxima*

The genus *Haplothrips* Amyot and Serville 1843 is a large cosmopolitan genus of the Family Phlaeothripidae in the Order Tubulifera. The species of this genus possess an ectoentarcine pseudunguis on all tarsi in both sexes (Bhatti 1994, 1998a). This structure is present in the type species *H. aculeatus* (Fabricius) and in other species of the genus that have been examined and in species of most genera of Phlaeothripidae, and is therefore a tubuliferan plesiotypy. The new species described here has the habitus of *Haplothrips* but lacks a hamus on mid and hind tarsi. In common with *Haplothrips* s. str., this species has asymmetrical antennal segment III, 4 sense cones on segment IV, segment VIII not constricted at base, 2 pairs of sigmoid setae on abdominal terga II to VII, and transverse prosternal basantral plates. The fore tarsus is armed in both sexes (Ananthakrishnan and Sen 1980).

## ABBREVIATIONS USED

*aa* - anteroangular, *am* - anteromarginal, *ml* - midlateral, *pa* - posteroangular, *ep* - epimeral, *cx* - coxal, *l* - length, *w* - width

## *Ahamothrips* gen. nov.

Head slightly longer than broad. Postocular seta well-developed and pointed. Eyes not bulging, ventrally not longer than dorsally. Proboscis short and broadly rounded. Maxillary stylets retracted far into the head. Maxillary bridge present (Fig. 1). Antennae 8-segmented; segment III asymmetrical. Segment VIII not constricted at base, but its base is slightly narrower than the apex of segment VII. Antennal segment III with 1 to 2 sense cones, IV with 4 sense cones. Campaniform sensillum on segment II situated in distal half of segment (Figs 4, 5).

Prothorax. Notopleural sutures complete. All dorsal prothoracic setae (*aa*, *am*, *ml*, *pa*, *ep*) well developed, pointed, blunt or expanded at apex, posteroangular (*pa*) and epimeral setae (*ep*) are the longest. Coxal seta (*cx*) well-developed and pointed or expanded at apex. Basantral plates present, transverse (Fig. 1).

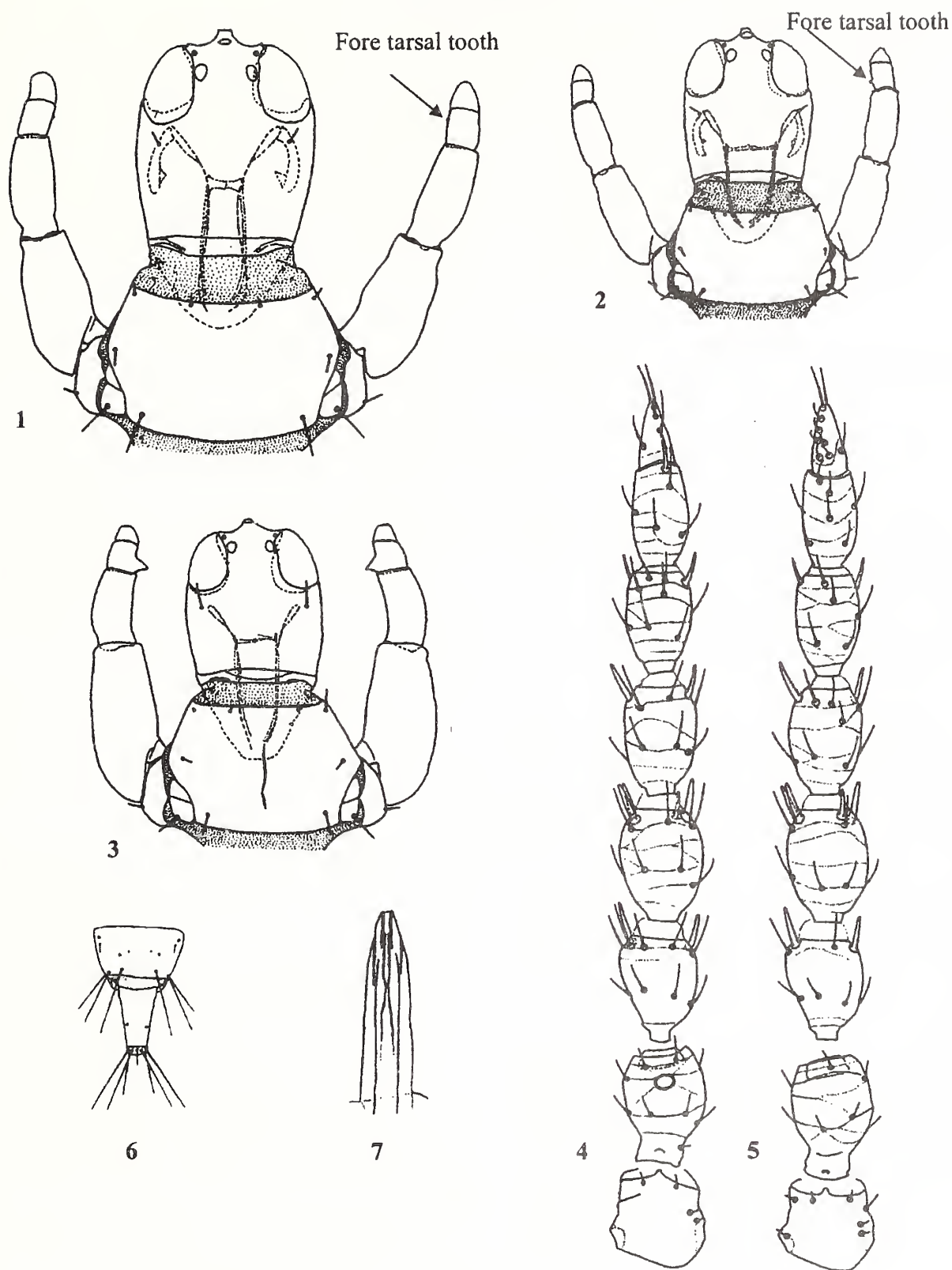
Mesoacrotergite deeply constricted at middle. Median metanotal setae of group 'a' well-developed and pointed, 3 minute setae of group 'b' sublaterally on either side are present, and setae of group 'c' are absent. Mesopresternum degenerate at middle.

Mesothoracic spiracle ventrally extends down to most of the posterior margin of infrapreepisternum. Metathorax without sternopleural sutures. Anapleural sutures complete.

Fore femur with apical margin somewhat raised exteriorly. Fore tarsus 1-segmented, mid and hind tarsi 2-segmented. Fore tarsus with ectoentarcine pseudunguis (H-1 hamus), mid and hind tarsi without hamus (H-3 hamus) (Figs 8-10). Fore tarsus armed with a tooth in female (Fig. 1) and a strongly developed triangular tooth in oedymorous male (Fig. 3).

Fore wing constricted at middle, just next to median bulge (MB) (Bhatti 1991: 46). Duplicated cilia present. Wing basal setae expanded apically and arranged in a triangle. Abdominal tergum I divided into 7 tergites: median tergite (pelta) triangular; antepelta divided (Bhatti 1998b: 289, and Fig. 10 on p. 299) into 2 discrete sclerites, the two halves very wide apart; the spiracles are located on a lateral tergite. Abdominal terga II to VII each with 2 pairs of sigmoid setae.

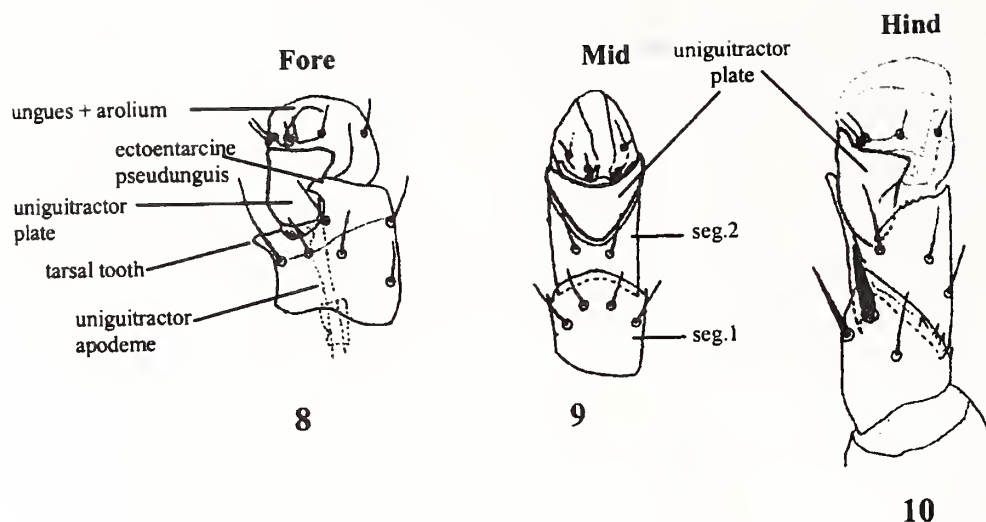
Tergum IX with S1 and S2 setae pointed, about as long as tube. In male the S2 setae are spine-like and much shorter than S1. Tube short and conical, much shorter than head. Anal setae as long as tube (Fig. 6). Male without gland area on sternum VIII.



Figs 1-7: *Ahamothrips maxima* n. gen. et. sp. n.:

1. Head and prothorax, dorsal, ♀; 2. Head and prothorax, dorsal, ♂ (Maximum gynaeoid);
3. Head and prothorax, dorsal, ♂ (Maximum oedymeros); 4. Antenna, dorsal, ♀; 5. Antenna, ventral, ♀;
6. Abdominal segments 9-10, dorsal, ♀; 7. Pseudovirga, ♂





Figs 8-10: Fore, mid and hind tarsi of *Ahamothrips maxima* n. gen. et. sp. n. ♀

**Etymology:** The name of the genus is based on the absence of hamus (ectoentarcine pseudunguis) on the mid and hind tarsi.

**Type species:** *Ahamothrips maxima* sp. nov.

*Ahamothrips maxima* sp. nov. (Figs 1-10)

**Female:** Macropterous.

**Structure:** Head 249 µm long, up to anterior margin of eye 232 µm, widest across middle 194 µm. Postocular seta 24 µm long, blunt at apex. Maxillary bridge W 38 µm (1/5 times width of head at that level). Width of head at maxillary bridge 191 µm.

Antennae 8-segmented; segment III asymmetrical. Segment VIII not constricted at base, but base is slightly narrower than apex of VII. Antenna 317 µm long; L (W) of antennal segments: III 37.5(31); IV 41 (32.4); V 39 (30); VI 41

(24); VII 44.3 (20.5); VIII 25.5 (13) µm. Antennal segment III with 2 sense cones, IV with 4 sense cones (Figs 4, 5).

Prothoracic notopleural sutures complete. Pronotum 157 µm long. Pronotal seta *am* slender and pointed, 14 µm long; other major setae stout and blunt at apex, *aa* 17, *ml* 17, *pa* 39; epimeral seta (*ep*) 41-50; *cx* 17 µm long.

Fore femur with apical margin somewhat raised exteriorly. Fore tarsus armed, with a small tooth (Figs 1, 2).

Fore wing 837 µm long, with 5-8 duplicated cilia. Wing basal setae S1 27; S2 27; S3 41 µm long, expanded apically and fringed, arranged in a triangle; fringe cilia at apex of wings smooth, not plumose.

Median tergite (pelta) triangular. Abdominal terga II to VII each with 2 pairs of sigmoid setae. Tergum IX 89 µm long. S1 97; S2 94-99; S3 70 µm long; S1 and S2 on tergum IX pointed.

Tube 123 µm long, *w* at base 65 µm, *w* at apex 34 µm. Anal setae S1 119-124; S2 143; S3 92 µm long.

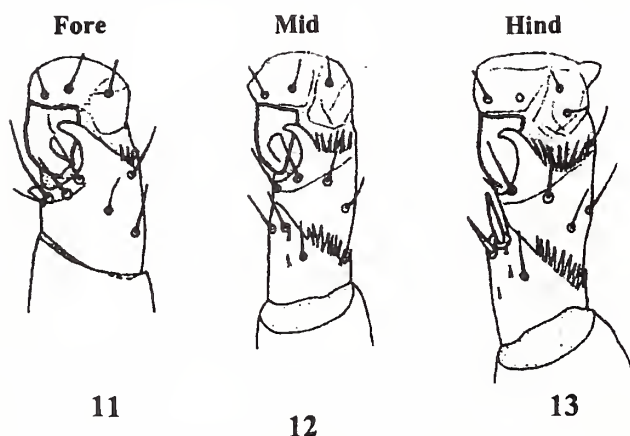
**Total body length:** 2.1-2.3 mm.

**Male:** Macropterous.

General structure similar to that of female. Fore tarsus armed, with a small tooth (Fig. 2) (very well-developed in oedymorous males, Fig. 3). Abdominal sternum VIII without gland area. Tergum IX with S1 pointed and S2 setae spine-like (Fig. 6).

**Total body length:** 1.65 mm (maximum gynaecoid) to 1.95 mm (maximum oedymorous).

**Colour:** Body dark brown, including legs, except the pale yellow tarsi and distal end of fore tibia. Antennal segments I and II dark brown, VII and VIII brown, III to VI yellow tinged



Figs 11-13: Fore mid and hind tarsi of *Haplothrips aculeatus* (Fabricius) ♀

with faint brown. Wings clear, unshaded, but with light brown clavus and adjoining area of wing blade.

**Material Studied.** Holotype ♀, Delhi, 29.vii.2002, from *Urochloa maxima* (Jack) R.D. Webster (Poaceae), leg. Kaomud Tyagi & Vikas Kumar. Paratypes 8 ♀, 7 ♂, with the same data.

**Etymology:** The species name is the same as that of the specific epithet of its host species *Urochloa maxima*.

**Remarks:** The new genus *Ahamothrips* is closely related to *Haplothrips*, in the presence of asymmetrical

antennal segment III, 4 sense cones on segment IV, segment VIII not constricted at base, 2 pairs of sigmoid setae on abdominal terga II to VII, and transverse prosternal basantral plates. The fore tarsus is armed in both sexes, except for the absence of ectoentarcine pseudounguis on mid and hind tarsi (Figs 11-13).

*Ahamothrips maxima* also shows striking sexual dimorphism in the width of maxillary bridge, a feature also shared by some species in *Haplothrips*.

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## A NEW SPECIES OF THE GENUS *GASTRANCISTRUS* WESTWOOD (HYMENOPTERA: PTEROMALIDAE) FROM INDIA<sup>1</sup>

ANKITA GUPTA<sup>2,3</sup> AND M.A. KHAN<sup>2,4</sup>

<sup>1</sup>Accepted September 27, 2005

<sup>2</sup>Biocontrol & Biosystematics Laboratory, Department of Entomology, GBPUA&T, Pantnagar 263 145, Uttarakhand, India.

<sup>3</sup>Email: ankitagupta9@rediffmail.com

<sup>4</sup>Email: maknan@rediffmail.com

A new species of Pteromalidae, namely *Gastrancistrus pantnagarensis* Gupta and Khan sp. nov. from Uttarakhand, India has been described and illustrated, and a revised key to the species of Indian *Gastrancistrus* given.

**Key words:** Hymenoptera, Pteromalidae, *Gastrancistrus pantnagarensis* sp. nov.

### INTRODUCTION

The genus *Gastrancistrus* was erected by Westwood in 1833 with *Gastrancistrus vagans* Westwood as the type species. Boucek (1988) enlisted the already known synonyms of *Gastrancistrus*, namely *Glyphe* Walker (Walker 1834), *Tridymus* Ratzeburg (Ratzeburg 1848) and *Tripedias* Forster (Forster 1856).

Some of the species are extremely different from the type species and the number of generic synonyms reflects the fact that the genus is very plastic. The number of teeth on mandibles, which are constant as four in European species, varies greatly in Indian species. The females of the genus, as understood by Boucek (1988), have five funicular segments and the males six. In all the species, so far described, the clypeal margin is only slightly or moderately produced.

Boucek (1986) described a new subgenus *Magistrus* with *Gastrancistrus (Magistrus) cherryi* as the type species from *Procontarinia matteiana* galls on mango leaves in Bangalore, India. Narendran *et al.* (2001) described a new species *G. bengalicus* which stands between *Amuscidea* Girault and *Gastrancistrus* Westwood.

Boucek (1988) stated that when better known, the presently separated genera *Amuscidea* Girault (Girault 1913) and *Premiscogaster* Girault (Girault 1933) will be merged with *Gastrancistrus*. Since the species *G. bengalicus* and *G. bidentatus* show intermediate characters between *Gastrancistrus* and *Amuscidea*, Narendran *et al.* (2001) reduced *Amuscidea* to a new junior synonym and a subgenus of *Gastrancistrus* Westwood. In India, so far, only two species, namely *G. muneswari* (Yadav) (Yadav 1978) and *G. (Magistrus) cherryi* Boucek are known. Boucek (1986) synonymised *Gastrancistrus mangiferae* (Subba Rao 1981) with *G. muneswari* Yadav. In this paper a new species is described and a revised key of Indian species given. The holotype is

deposited in the collections of the Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.

### MATERIAL AND METHODS

The specimens were studied in the Biological Control Laboratory, Department of Entomology at the Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, using a trinocular microscope. The drawings were made using Camera Lucida. Leaves parasitized with eggs were collected and stored in labelled jars for the emergence of parasitoids. The collected specimens were preserved in 70% alcohol in glass vials. Permanent slides were prepared to enable detailed study of important structures of the parasitoids.

Slides were prepared using the method mentioned below:

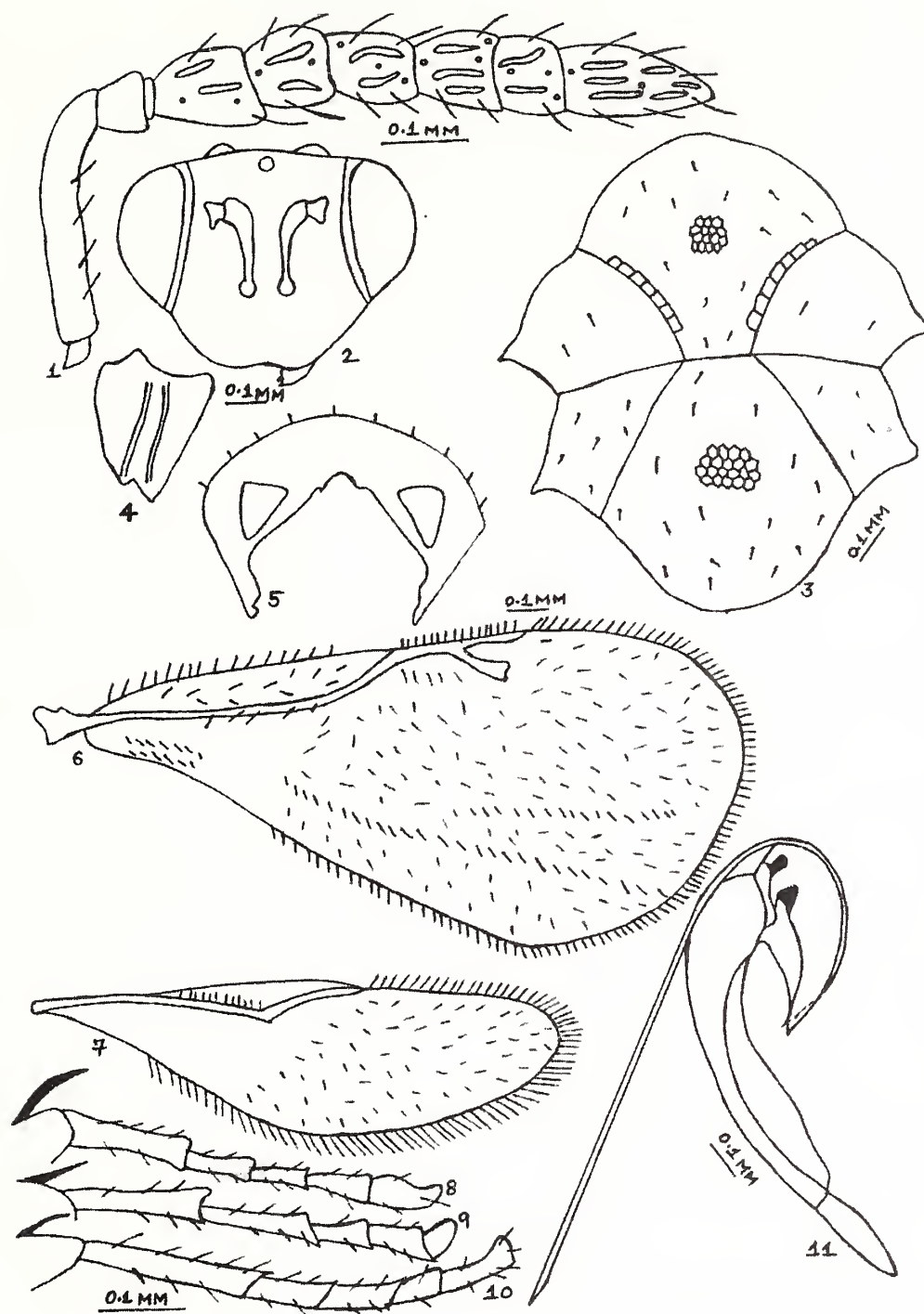
- (1) It was ensured that the specimen was dry. As the specimen to be mounted was in alcohol, it was dried in an oven at about 60° C before proceeding.
- (2) Specimen was soaked in a 7:5 mixture of glacial acetic acid (or lactic acid) and lacto phenol (or chloral phenol) at room temperature for 24-72 hrs, after which the specimens were cleared and the body shape returned to normal. The cleared specimens were mounted in Hoyer's medium.

### RESULTS AND DISCUSSION

*Gastrancistrus pantnagarensis* sp. nov. (Figs 1-11)

**Female:** Body length about 2.50 mm (Holotype); general body colour black; eyes brown and ocelli yellowish brown; antennae uniformly yellowish brown; lateral arms of pronotum black and middle portion blackish brown; thorax black with coarse reticulation; wings hyaline; legs brown; fore and middle





Figs 1-11: *Gastrancistrus panthagarensis* sp. nov. Female: 1. Antenna; 2. Head in frontal view; 3. Thorax; 4. Left mandible; 5. Pronotum; 6. Forewing; 7. Hindwing; 8. Tarsi of fore leg; 9. Tarsi of mid leg; 10. Tarsi of hind leg; 11. Ovipositor

tibia and tarsi brownish black, hind coxa and femur black, hind tibia brown; abdomen black with bright reflection.

**Head:** Wider than long in facial view (0.71:0.53); frontovertex distinctly wide, more than half of the total head width (0.36:0.71); ocelli arranged in obtuse angle triangle; POL slightly smaller than OOL (0.06:15); diameter of media ocelli

(0.035) smaller than POL (0.035:0.06), malar space smaller than total eye width (0.18:0.71); antennae inserted not so low on face; width of frons between eyes is 6x more than distance between two toruli (0.36:0.06); scrobe shallow, not reaching front ocellus; clypeus not distinctly separated by groove or line from face; right and left mandible tridentate (two teeth

and a truncation) with blunt margins, maxillary and labial palpi 4 and 2 segmented respectively. Antennal formula 11151; with one ring segment; scape not exceeding fronocellus, more than 9.5x times as long as wide (0.39:0.04); pedicel slightly wider than long (0.06:0.05); funicle five segmented; first funicle segment longer than wide (1.2:0.099); second funicle segment slightly wider than long (0.095:0.09); third segment longer than wide (0.095:0.085); fourth segment as wide as long (0.09:0.09); fifth segment wider than long (0.09:0.08); club unsegmented and two times longer than wide (0.17:0.08).

**Mesosoma:** Densely setose with coarse reticulation; pronotum narrow in dorsal view; antero-lateral arm of pronotum bend inside anterior margins concave and posterior margin convex; mesosoma longer than wide (0.12:0.8); mesoscutum shorter than scutellum (0.55:0.625), mesoscutum wider than head in dorsal aspect (1.07:0.71); mesoscutum wider than scutellum (1.07:0.94); axillae triangular, widely separated from each other, notauli deep and complete, with distinct rectangular cells.

Mesoscutum and scutellum with dense setae; scutelloaxillar sutures meeting the hind margin of mesoscutum at approximately almost at the same point as the hind ends of notauli; apex of scutellum rounded; mesoscutum and scutellum reticulate. Propodeum smooth without median carina; plicae absent; spiracle oval, callus not pubescent; hind coxa not pubescent on dorsal side. Forewing two times as long as wide (1.57:0.8); densely setose; costal cell broad and sparsely setose; speculum broad and closed below; submarginal vein almost four and a half times marginal vein (0.8:0.18); post marginal vein shorter than stigmal vein (0.15:0.18); basal cell almost bare; marginal fringes short, spaced by a distance almost equal to half their length. Hind wing 3.3 times longer wide (1.26:0.38); disc setose. Fore tibial spur shorter than basitarsus (0.11:0.15); middle tibial spur slightly shorter than basitarsus (0.07:0.17). Hind coxa longer than wide (0.5:0.3); hind femur about four times as long as wide (0.78:0.22); hind tibia slightly longer than hind femur (0.82:0.78).

**Metasoma:** 2.3 times as long as mesosoma; longer than wide (1.35:0.75), longer than combined length of pronotum, mesoscutum and scutellum (1.35:0.85); ovipositor projecting (exserted); first valvifer triangular, third valvulae three times as long as wide (0.23:0.7), second valvifer longer than the length of outer plate of ovipositor, outer plate of ovipositor five and a half times as long as wide (0.84:0.15).

**Male:** Not known

**Holotype (Female):** India, Pantnagar (29° N, 79° E), unidentified egg patch on *Saccharum officinarum* plant, 10.ix.2004, Hym., Ptero., 01 BC, Ankita Gupta.

**Paratype:** 6 females of same data as Holotype. Hym., Ptero., 02 BC, 03 BC, 04 BC, 05 BC, 06 BC, 07 BC Ankita Gupta.

**Host:** Unidentified egg mass on *Saccharum officinarum*.

**Remarks:** This species *G. pantnagarensis* sp. nov. differs from *G. (G.) bengalicus* Narendran in having F1 and F3 longer than wide, mesoscutum wider than head width, scutellum wider than long, absence of frenal line, mesoscutum and scutellum reticulated and scutellum more coarsely reticulated as compared to the mesoscutum. This species differs from *G. (M.) cherryi* Boucek in not having eye angularly pointed toward sides.

#### REVISED KEY TO INDIAN SPECIES OF *GASTRANCISTRUS* WESTWOOD

1. Mandibles bidentate; eye angularly pointed towards side; scutello-axillar sutures meeting a little mesad of the hind end of notauli ..... *G. (M.) cherryi* Boucek
- Mandibles tri or quadridentate; eye not angularly pointed towards side; scutello-axillar sutures meeting at the hind margin of mesoscutum at approximately the same point as the hind ends of notauli ..... 2
2. Mandibles tridentate; F1 to F4 wider than long ..... 3
- Mandibles quadridentate; F1 to F4 longer than wide ..... 4
3. Mandibles tridentate when viewed from outside (with a tubercle inside on mandible); wider than long; F1 to F4 not longer than wide; occiput deeply concave; legs including coxae yellowish white; head subtriangular ..... *G. (G.) bengalicus* Narendran
- Mandibles tridentate (2 blunt tooth and a truncation); F2 slightly wider than long and F4 almost as wide as long; F1 and F3 longer than wide, legs brown, coxa dark brown ..... *G. (G.) pantnagarensis* sp. nov.
4. Mandibles quadridentate; F1 to F4 segments longer than wide; occiput not deeply concave; fore coxa brownish black; hind coxa pale yellowish brown with a black metallic patch above; colour of femora pale yellowish brown with base and apex paler, head not as above ..... *G. (G.) muneshwari* Yadav

#### ACKNOWLEDGEMENT

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# A NEW SPECIES OF TELEOSTEI: *PUNTIUS POOKODENSIS* (CYPRINIDAE) FROM WAYANAD, KERALA, INDIA<sup>1</sup>

T.V. ANNA MERCY<sup>2,3</sup> AND EAPEN JACOB<sup>2,4</sup>

<sup>1</sup>Accepted March 23, 2006

<sup>2</sup>College of Fisheries, Kerala Agricultural University, Panangad, Kochi 682 506, Kerala, India.

<sup>3</sup>Email: annamercy2002@yahoo.co.in

<sup>4</sup>Email: eappenjacob@rediffmail.com

*Puntius pookodensis* is described as a new species of *Puntius* from Pookode Lake, Wayanad, Kerala. It is characterised by the combination of the following characters: serrated, spiny dorsal ray, incomplete lateral line, 22-23 scales in lateral series, lateral transverse rows 4/3 ½, 18 circumferential scales, a shoulder spot and one or two spots on the caudal peduncle. The species is compared with its closest relatives, the widespread *Puntius ticto* and *P. punctatus* found in southern India, and with a look-alike *P. shalynius* from north-east India.

**Key words:** Cyprinidae, *Puntius pookodensis* sp. nov., *Puntius ticto*, *Puntius punctatus*, Kerala

The genus *Puntius* Hamilton, belonging to Family Cyprinidae, represented by small to tiny fishes, is widely distributed in south and south-east Asia. The species of this genus usually have a single pair of maxillary barbels or none, and the principal dorsal spiny ray may be smooth, osseous or serrated. During a survey of the Kerala waters for ornamental species, the authors from Fisheries College collected an interesting colourful *Puntius* species from a remote lake in the pristine Wayanad hills. This, on further study, turned out to be new to science and is described here.

Based on earlier studies (Day 1875-78, 1889; Talwar and Jhingran 1991; Jayaram 1991, 1999; Menon 1999; Pethiyagoda 1991) and recent descriptions (Vishwanath and Laisram 2004), there are 17 species in the Indian subcontinent sharing common features with the new species, namely absence of barbels and serrated principal spiny ray of dorsal fin. A key to all these species is provided, mostly based on colour pattern, since this character seems to be species specific.

## MATERIAL AND METHODS

Descriptions are based on 27 specimens, 22 of them deposited in the fish collections of the Zoological Survey of India, Southern Regional Station, Chennai and five in the fish collections of the Zoological Survey of India, Calicut. Measurements follow standard practices and the mean values followed by range in parenthesis are provided.

## RESULTS & DISCUSSION

*Puntius pookodensis* sp. nov. (Figs 1, 2)

**Holotype:** F.7635, ZSI/SRS (Zoological survey of India/

Southern Regional Station) 40 mm standard length (SL), Pookode lake 76° 01' E, 76° 18' E and 11° 7' N, 11° 42' N, Wayanad district, Kerala, India, collected by Anna Mercy and Eapen Jacob, November 2004.

**Paratype:** F.7636, ZSI/SRS, 21 exs. 26.0-42.0 mm. SL., data same as for holotype. 5 exs in the Zoological Survey of India, Calicut ZSI. (WGRS) CLT No. V/F. 13258.

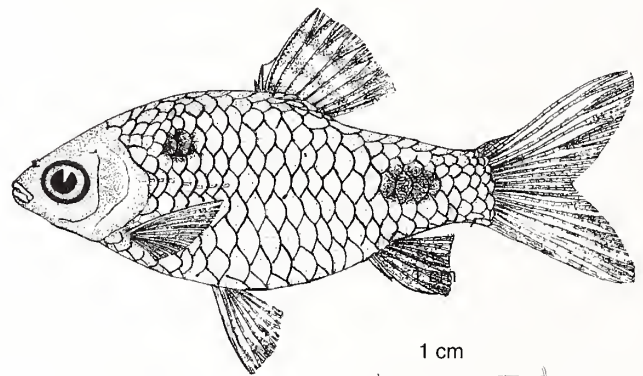


Fig. 1: *Puntius pookodensis* sp. nov. Female

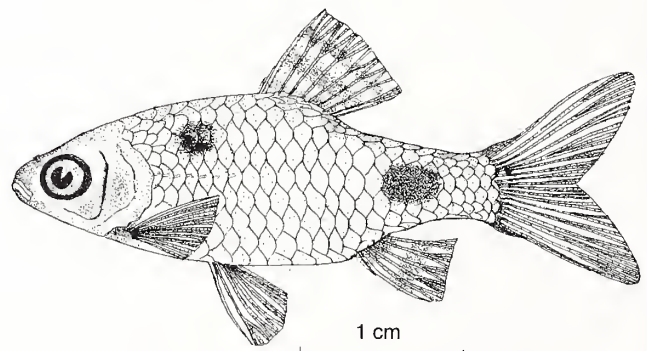


Fig. 2: *Puntius pookodensis* sp. nov. Male

**Diagnosis:** An elongate *Puntius* species not more than the 43.0 mm SL, without barbels and with an osseous principal spiny dorsal ray and mostly with seven branched rays; an incomplete lateral line with 6-8 pored scales, 22-23 lateral scale rows, with  $4\frac{1}{2}$ / $3\frac{1}{2}$  lateral transverse scales; 18 circumferential scales, a shoulder spot on the lateral line and one or two spots on the caudal peduncle.

**Description:** D. iii/6(2), 7(21), 8(2); P. 1/12-13; V. 1/7/I; A. iii/5; C. 19. Body elongate, its depth 3.87 (3.97-4.27) in total length (TL), 3.10 (2.83-3.27) in standard length (SL); its width 2.21 (1.83-2.44) in its depth; head small, its length 4.46 (3.90-4.90) in TL, 3.49 (3.10-3.80) in SL; eyes large, its diameter 3.08 (2.75-3.75) in head length (HL), 1.07 (1.00-1.43) in interorbital width, 0.88 (0.71-1.17) in snout; snout pointed 3.54 (2.86-4.00) in HL; pectoral short, 1.36 (1.25-1.57) in HL; caudal peduncle slender, its depth 1.46 (1.30-1.60) in its length, gill rakers 6 on the lower arm of the first gill arch and 2-3 on the upper arm.

Scales large, lateral line incomplete, pored scales ceasing after 6<sup>th</sup> or 8<sup>th</sup> scales; scales along lateral line 22-23; 4 rows in lateral transverse series from dorsal fin origin to lateral line, 3.5 from lateral line to pelvic fin base; predorsal scales 8-9; post dorsal 10-10½; prepelvic 9-10; circumferential scales 18, circumpeduncular scales 12.

**Colour:** Fresh specimens with an iridescent silver body and yellowish fins; a shoulder spot on the 3<sup>rd</sup> to 4<sup>th</sup> scale along lateral line and another prominent spot on the 16<sup>th</sup> to 17<sup>th</sup> scale and sometimes a faint spot on the 19<sup>th</sup> and 20<sup>th</sup> scales, a thin dark line extends from the anterior to the posterior spot. Maximum length observed: 43.0 mm SL.

**Distribution:** INDIA: Kerala, Wayanad district, Pookode lake.

**Etymology:** The new species is named after the type locality.

**Comparative material:** *Puntius ticto*: F 6034 ZSI/SRS, 8 exs. 29.0-35.0 mm SL; 8.x.1998 Singaperumal koil paddy field, Chennai, coll. M.B. Raghunathan; F.6620, 7 exs. 25.0-34.0 mm SL, 18.iv.2004, Singaperumal koil paddy field coll. M.B. Raghunathan.

*Puntius punctatus*: 2 exs. 47.0-49.0 mm SL. Muvattupuzha river, coll. Anna Mercy & Eapen Jacob. September 2004.

**Remarks:** Seventeen *Puntius* species share certain common characters, namely absence of barbels and a serrated principal spiny ray of the dorsal fin. However, each bears some unique features by which they can be differentiated from the rest. The new species bears close resemblance to the two spotted species, *Puntius ticto* and *Puntius punctatus*, the former known to be widely distributed in India and replaced by the latter in the south-western tip of peninsular India, and perhaps also in Sri Lanka. However, the new species differs

from *punctatus* in its incomplete lateral line system and in the position of the spots. The shoulder spot being present on one scale row below the lateral pored scale and presence of a larger spot in the middle of the caudal peduncle in *punctatus* versus shoulder spot on the L.I. row and the caudal spot at the anterior half of the caudal peduncle in the new species. The new species can be separated from *P. ticto* in its less deep body, circumferential scales (18 versus 22 in *ticto*).

The species further bears some resemblance in the lesser number of branched dorsal rays (7) and paired caudal spots to *P. shalynius* found in the streams, lakes and pools in the Khasi and Jaintia Hills, Meghalaya. However, the new species differs from the same in the presence of a variable number of branched rays in the dorsal (6-8), the presence of a shoulder spot and in the caudal spots, which is paired and of equal size in *shalynius*; in the new species the anterior caudal spot is larger and the posterior spot is fainter or absent in many specimens. The new species seems to have evolved in isolation in Pookode lake in the pristine Wayanad Hills in southern Western Ghats from the same stock as the widespread *P. ticto*, as would have its congener *shalynius* in the Khasi and Jaintia Hills in the north-east.

#### KEY TO THE *PUNTIUS* SPECIES WITH A STRONG, OSSEOUS AND SERRATED PRIMARY DORSAL FIN RAY AND WITHOUT BARBELS

1. Lateral line scales (L.I.) more than 30 ..... 2
- Lateral line scales (L.I.) less than 30 ..... 3
2. Scales large, L.I. 31-33, no spots on body ..... *P. nangalensis*
- Scales small, L.I. 36-39, a spot near caudal base.... *P. guganio*
3. Body with vertical bands ..... 4
- Body without vertical bands but with one or two spots/blotches ..... 11
4. Body with 4 vertical bands ..... *Puntius phutunio*
- Body with 3 or less number of vertical bands ..... 5
5. L.I. complete, body with 3 vertical bands ..... 6
- L.I. mostly incomplete, body with variable number of bands ..... 7
6. Body deep, 2 in SL, L.tr. 5/4 ..... *P. nigrofasciatus*
- Body less deep, 2.5 in SL, L.tr. 4.5/3.5 ..... *P. setnai*
7. Shoulder band absent, bands only on caudal peduncle ..... 8
- Shoulder band always present ..... 9
8. Two vertical bands on caudal peduncle; dorsal and anal base dark, L.I. incomplete ..... *Puntius gelius*
- Body with a single band around caudal peduncle, fin bases not dark, L.I. complete or incomplete ..... *P. ornatus*
9. Dark saddle shaped band between eyes; dorsal, ventral and anal fins dark, L.tr. scales between L.I. and pelvic fin about  $4\frac{1}{2}$  ..... *P. bandula*
- Coloration not as above; dorsal with bands or spots, L.tr. scale rows less than  $4\frac{1}{2}$  ..... 10
10. Circumpeduncular scales 12 ..... *P. bizonatus*
- Circumpeduncular scales 8-10 ..... *P. cumingii*
11. Two spots on body, a shoulder spot and one on caudal peduncle ..... 12

## NEW DESCRIPTIONS

- Shoulder spot absent ..... 16
- 12. Lateral line complete; shoulder spot not on L.I ..... 13
- Lateral line incomplete; shoulder spot on L.I ..... 14
- 13. Shoulder spot one row above 3<sup>rd</sup> scale of L.I.; dorsal fin not spotted ..... *P. stoliczkanus*
- Shoulder spot one row below L.I.; dorsal fin spotted in rows ..... *P. punctatus*
- 14. Body slender, circumferential scales less than 20 ..... 15
- Body deeper, circumferential scales 22 ..... *P. ticto*
- 15. Dorsal fin with 8 branched rays, L.tr. 3½ / 3½ caudal spot above tip of anal fin ..... *P. manipurensis*
- Dorsal usually with 7 branched rays rarely 8; L.tr. 4-4½ / 3½; caudal spot above anal fin, another faint spot posterior to this ..... *P. pookodensis*

- 16. Two spots on caudal peduncle ..... *P. shalynius*
- A single blotch on caudal peduncle ..... *P. conchoniis*

## ACKNOWLEDGEMENTS

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## REVIEWS

1. INSECTS OF INDIA, by Tapan Sengupta. Published by the author, Tapan Sengupta, 2005. 284 pp. Size: 24.5 cm x 18.5 cm. Hardback Price: Rs. 850/-, US\$ 100/-.

I opened the book and read the first few pages – the Foreword and Preface – with great enthusiasm, but was disappointed with contents of the book. In the Introduction, the author has mentioned 16 major orders of insects, forgetting one of the important Orders – Dictyoptera (roaches and mantids), though he has mentioned it in the main text.

The book has three different sections. Part One provides information on Classification of insect species of India and the world, but the author has not mentioned which taxonomic classification is currently being used. The information given on each Order is insufficient to get an overall picture of that group. E.g. the fact that cockroaches and mantis lay eggs in a case known as ootheca; the nymphs of dragonflies are known as naiads; the Giant Water Bug is *Belostoma indicum* and not *Sphaerodema rusticum*, but a common name is given to both of them in the text. Under Order Lepidoptera, butterflies are classified as per the old classification. The information on insect collection and preservation techniques, along with equipments required for the same, will be of use to the students interested in the study of insects. It also has information on important protected areas in different states of India.

Part Two provides details on vegetation, climate and different habitats of India. The information on important localities for the study of various insect groups along with route maps to reach these areas will help to plan insect surveys.

Part Three deals with learning about insects. The author has tried to answer various questions that may be asked by the common man. However some of the answers are not complete: for instance in insect mimicry, the ideal example of the female of the Danaid Eggfly butterfly mimicking the Plain Tiger butterfly is not mentioned, similarly answers to protective coloration and camouflage insects are same. While listing the differences between butterflies and moths, the author could have mentioned that though butterflies are active during the day, some like the evening browns are active at dusk, and similarly there are day flying moths. The mantids are not mentioned in predatory insects. The illustrations and photographs are of average quality. There are nine colour plates having photographs of insect habitats and a few insects like butterflies, moths and beetles. The book has no popular appeal and is of little significance to insect lovers.

■ NARESH CHATURVEDI

2. CATFISHES OF INDIA, by K.C. Jayaram. Narendra Publishing House, Delhi. 2006. 383 pp. Size: 24.5 cm x 19 cm. Hardback. Price: Rs. 1695/-, US\$ 165/-.

Constantly changing names have been the bane of biologists dealing with the systematics of any group, and fishes are no exception. Even though Sir Francis Day's monumental work on FISHES OF INDIA was published over a century ago, it still remains the Bible for Indian ichthyologists, with its excellent illustrations and descriptions. It has become dated only because many of the generic names of fishes have since changed.

Just thirty years ago, Dr. K.S. Misra of the Zoological Survey of India (ZSI) had published an excellent treatise on the Catfishes of the Indian subcontinent, including those from Pakistan, Bangladesh, Nepal, Burma and Sri Lanka. There is a silver lining to every cloud; changes in Nomenclature in these thirty years have enabled Dr. K.C. Jayaram, also of the ZSI, to bring out a revised version of Indian catfishes.

This work bears the individual stamp of Jayaram's style of writing. He has devoted a considerable part of his scientific career to the systematic study of catfishes. Dr. Jayaram is already well known across today's generation of Indian

ichthyologists from his two books on Indian freshwater fishes (1981, 1999). Marine ichthyologists, after a superficial glance of these two books might have bemoaned the fact that he has restricted his studies to freshwater fishes, but a more careful perusal will reveal the inclusion of quite a few estuarine fishes, which can tolerate freshwater conditions.

In his current book, too, a major portion is devoted to fresh water catfishes. This restriction is not his personal choice; it just happens that most catfishes are fresh water denizens. However, a substantial portion, comprising 33 pages (319 to 352) is devoted to marine catfishes belonging to families Plotosidae and Ariidae.

No one can find fault with Jayaram's taxonomic account. Editing and proof-reading have been adequately done, unlike his 1981 book, in which while reviewing it I could find as many as 105 spelling mistakes in addition to many technical mistakes. The quality of illustrations is also, on the whole, very good. But it is the colour photographs which are not up to the mark. In many publications where the text matter is

mediocre, authors resort to embellishing their papers with colour photographs. This is definitely not the case with this book. I can understand the use of colour photographs when describing coral-reef fishes, with their gaudy "poster" colours. But, in a group comprising the usual fish coloration of steel-grey on the dorsal region merging to white on the ventral (nature's strategy of camouflage by counter-shading), colour photographs are superfluous, especially in the case of

preserved specimens with misshapen, distorted bodies. Or was it because surplus funds were available?

Incidentally, the matter in the book will form part of the All Catfish Species Inventory (ACSI) of the W.S. National Science Foundation. But it can be used as an independent reference material by students and ichthyologists alike.

■ B.F. CHHAPGAR

3. FOREST TREES OF SOUTH INDIA by S.G. Neginhal. Published by the author, S.G. Neginhal, IFS (Retd.), 2004. lxxii + 447 pp. + 32 colour plates (92 photographs). Size: 22 cm x 14.5 cm. Hardback. Price: Rs. 895/-

This book is in line and format of Dietrich Brandis' INDIAN TREES (1906), and it covers 988 trees from Goa, Pondicherry, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh, and partly from Maharashtra.

The main purpose of conservation is maintaining the biodiversity of any region. The first step towards this goal is documentation. This baseline documentation serves the cause of monitoring and evaluating the health of the biodiversity. Once documentation is accomplished the results have to reach the common people to inform and educate them. Scientific works, on a number of occasions, are not clearly understood by the lay man and therefore there is need to place them in simple language. The purpose of this book is precisely this.

Neginhal restricts the scope to the species found in forest areas (introduced trees not included), but his concept of a tree is not very clear. He has included species like *Cocculus laurifolius* DC. (a scandent climber), *Capparis decidua* (Forsk.) Edgew., *Capparis sepiaria* L. (low branched bushy shrubs); while he has excluded woody climbers like *Ancistrocladus heyneana* Wall., *Entada pursaetha* DC., *Derris scandens* (Benth.) Roxb., *Calycopteris floribunda* (Roxb.) Lamk. among others.

The text is not uniform. The texts for some species like the *Bruguiera eriocarpa* W. & A. and *Eriolaena lushingtonii* Dun (one and half line), *Acacia bolei* Subhedar and *Memecylon modestum* Cogn. (2 lines), *Gyrinops walla* Gaern. and *Glochidion littoralis* Bl. (3 lines) – are very short; while that for some species like the *Stereospermum colais* (Buch.-Ham.) Mabb. (40 lines), *Alangium salvifolium* (L. f.) Wangerin (31 lines) and *Spondias pinnata* (L. f.) Kurz. – are too long.

Brandis' INDIAN TREES has many more species than this book. In case one already owns a copy of INDIAN TREES, this will just be one more book on the shelf. Though Neginhal has given the latest nomenclature for many species, he is not always correct, hence some of his identification could also be controversial.

Identity of species called *Syzygium cumini*, *Memecylon edule*, *Embelia basaal* DC., *Embelia tsjaricum-cottom* D.C. etc. require rechecking. I am yet to come across a species of *Memecylon* with edible fruits. Some authors consider *Garcinia spicata* (Wt. & Arn.) Hk. f. (No. 90), *Garcinia talbotii* Raizada ex Sant. (No. 92) and *Garcinia xanthochymus* Hk. f. (No. 95) as conspecific, for which the correct name is *Garcinia dulcis* (Roxb.) Almeida. *Murraya paniculata* (L.) Jack. and *M. exotica* L., and similarly *Cerbera manghas* L. and *C. odollam* Gaertn. are shown as synonyms. Modern taxonomic conclusions on these are *at variens*.

Since the publication of Neginhal's book, some names have undergone changes in nomenclature. The following names require fresh checking for which I invite the attention of the readers to the DICTIONARY OF PLANTS NAMES by M.R. Almeida & S.M. Almeida, 2005.

1. Plate 4, Photo 96. *Mammea suriga* [= *M. longifolia* (W.f.) Planch.]
2. Plate 9, Photo 299. *Sapindus laurifolius* [= *Sapindus trifolius* L.]
3. Plate 15, Photo 505. *Memecylon malabaricum* [= *Memecylon randerianum* Almeida]
4. Plate 16, Photo 539. *Anthocephalus chinensis* [= *Neolamarkia cadamba* (Roxb.) Bosser]
5. Plate 25, Photo 896. *Jatropha curcas* (This is actually *J. gossypifolia*)
6. No. 541. *Canthium dicoccum* var. *umbellatum* (Wt.) Sant. & Merch. (= *Psydrax umbellatum* (Wt.) Dresden)
7. No. 416 *Xylia xylocarpa* (Roxb.) Taub. [= *Esclerona xylocarpa* (Roxb.) Almeida]
8. No. 184 *Enodia luna-aukenda* (Gaertn.) Merr. [= *Melicope lummankenda* (Gaertn.)]
9. No. 307 *Buchanania lanzen* sp. [= *B. cochinchinensis* (Lour.) Almeida]
10. No. 36 *Sageraea laurifolia* (Graham) Blatter [= *S. laurina* Dalz.]

■ M.R. ALMEIDA



4. TROPICAL RAIN FORESTS: AN ECOLOGICAL AND BIOGEOGRAPHICAL COMPARISON, by Richard Primack and Richard Corlett. Blackwell Publishing, USA. 2005. 319 pp. Size: 25 cm x 17 cm. Hardback. Price: Not mentioned.

Tropical rain forests are one of the favourite habitats for conservationists to plead for their protection and also to lament about their continuing destruction. To the general public these forests are awesome, steamy, humid, mysterious and dangerous. To the biologists the tropical rain forest is the highest expression of life form on this planet (the other being the underwater tropical reefs).

The tropical rain forests form a broad belt around the equator, extending 5° to 10° to the north and the south. However, their presence and extent also depends on the interaction between wind direction and mountain ranges, variation in sea surface temperatures and other factors. It will be cliché to say that almost half of the world's tropical rain forest is found in tropical America, mainly in Brazil, Colombia and Venezuela. The second largest block of the tropical rain forest is in Africa, centered on the Congo River Basin. The third largest tropical rain forest area is in Asia – the Malay Peninsula and the large islands of Borneo, Sumatra, Java and Papua New Guinea. This rain forest extends westward through Myanmar into north-eastern India. In India, the rain forest is also found in the Western Ghats and the Andaman and Nicobar Islands. Perhaps not many people know that the tropical rain forest is also found in a small area of northern Australia and eastern parts of the Madagascar Island.

For most people, all tropical rain forests are similar. This is far from true. While we see many cases of convergent evolution and many similarities, each rain forest is different from the other. There are numerous ecological and geological factors, such as speciation, species dispersal and extinction, soil nutrients, rainfall seasonality, geological upheavals and movement of tectonic plates that create these differences. If one wants to know more about the tropical rain forests, I recommend this interesting book. While many technical books have been written on tropical rain forests, especially on the ecology of the Amazon forest, I find Primack and Corlett's book comprehensive and easy to read. The book is divided into eight chapters, each ending with further reading on the subject. At the end, a very exhaustive reference list is given, covering latest research papers/books on this fascinating and fast disappearing ecosystem. The book is neatly divided into sub-chapters and sections. For instance, the chapter on

Primate Communities is further subdivided into 'What are primates?', 'Old World versus New World primates' 'Primate diversity', 'Primate diets' and 'Primate communities'. The subchapter 'Primate diets' is further divided into sections such as Leaf-eaters, Insectivores and Frugivores. This makes very easy readings. The sections that do not fit in the flow of the book or which the authors want to highlight further are given in boxes. At the end of each chapter, conclusions and future research directions are given. The book is also profusely illustrated with colour and black and white pictures, diagrams, graphs and maps. The last chapter, 'The Future of Rain Forests' makes sad reading. The authors make a strong plea for the protection of the remaining tropical rain forests, especially those in the Neotropics and Asia that are seeing the fastest destruction.

The tropical rain forests are by far the richest in biodiversity of all terrestrial ecosystems in the world. Despite occupying only about 6% of the Earth's land surface area, it is believed that they support more than half of the total species of land plants and animals. In central and western Amazonia, in the Pacific Coast rain forests of Choco Province, Colombia, in the Atlantic Coastal Forest of Brazil, and in Sarawak, Malaysia, more than 250 species of trees have been found in a single hectare (p. 35). In comparison, even the most species-rich temperate forests have fewer than 25 tree species per hectare, and most have fewer than 10. Knowing this, is it not ecocide to destroy even a single hectare of tropical rain forest anywhere in the world? Are our Governments listening? Are world bodies like the United Nations Environment Programme doing enough to stop this destruction? Are the developed nations – the largest importers of the tropical forest timber – helping the poor countries stop this destruction? Like the ban on whaling, can't we have a ban on the export and import of timber removed (some say stolen) from the tropical forests? Or, is it asking for too much from the rich nations to pay? Incidentally, the largest importers of tropical wood are the G-5 nations! Is there connection between the loot of natural resources of one nation and richness of another? Perhaps, we need another book on this subject.

■ ASAD R. RAHMANI



## MISCELLANEOUS NOTES

1. A NOTE ON THE LATEX LICKING HABIT OF FIVE-STRIPED AND THREE-STRIPED PALM SQUIRRELS<sup>1</sup>SATISH KUMAR SHARMA<sup>2</sup><sup>1</sup>Accepted February 22, 2005<sup>2</sup>Foundation for Ecological Security, 18, New Ahinsapuri, Fatehpura, Udaipur 313 001, Rajasthan, India.

Email: sksharma@gmail.com

Information about the food habits of the Five-striped Palm Squirrel (*Funambulus pennanti*) and Three-striped Palm Squirrel (*F. palmarum*) comes from the work of Balasubramanian (1989, 1995), Barnett and Prakash (1975), Gupta and Agarwal (1968), Harit (1996), Mathew and Lukose (1995), Prater (1980), Sadakathulla and Kareem (1995) and Tiwari (1990). These squirrels primarily feed on fruits, nuts, young shoots, buds and bark. The Five-striped Palm Squirrel sometimes also feeds on birds (Harit 1996; Mathew and Lukose 1995; Tiwari 1990); the Three-striped Palm Squirrel even feeds on nectar and insects (Balasubramanian 1989; Prater 1980). Cannibalism has been recorded in both the Five-striped (Gupta and Agarwal 1968) and Three-striped Palm Squirrels (Sadakathulla and Kareem 1995).

During my field studies in various parts of Rajasthan, Haryana, Andhra Pradesh and Karnataka between 1996 and 2005 (Table 1), I found *F. pennanti* and *F. palmarum* licking

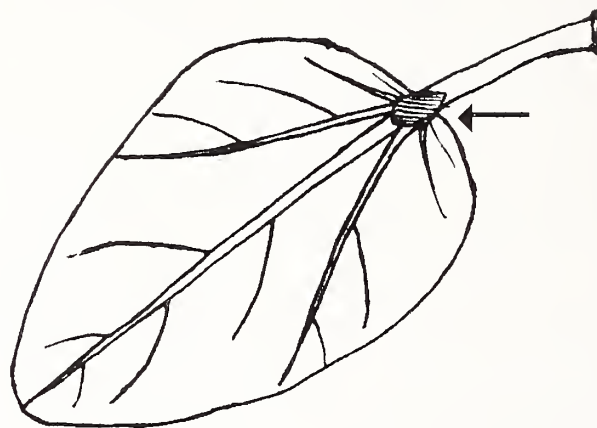


Fig. 1: Position on the abaxial surface of the leaf of *Ficus benghalensis* licked by squirrels

latex from the leaves of *Ficus benghalensis*. The latex is procured from the furcating point of basal veins at the abaxial surface of leaves (Fig. 1). Both the squirrels move quickly on

Table 1: Details of latex licking of *Ficus benghalensis* leaves by striped squirrels

Date of observation	Locality of observation	No. of leaves licked
<b><i>Funambulus pennanti</i></b>		
30.viii.1996	Brahminoka-Khairwara (Jhadol tehsil, Udaipur district, Rajasthan)	400
1.ix.1996	Madri (Jhadol tehsil, Udaipur district, Rajasthan)*	1000
29.viii.2002	Polo Forest (Vanaj, Gujarat)	700
27.xi.2004	Patauda (Jhajjar district, Haryana)	249
10.xi.2004	Chitrawas (Gogunda tehsil, Udaipur district, Rajasthan)	100
3.i.2005	Banswara (Rajasthan)	200
<b><i>Funambulus palmarum</i></b>		
26.ix.2004	Kokkanti Cross (Kadiri taluka, Annantpur district, Andhra Pradesh)	100
26.ix.2004	Thimmama Merry Manu (Kadiri taluka, Annantpur district, Andhra Pradesh)**	500
27.xi.2004	Royalpadu (Kolar district, Karnataka)	295***

\* Largest Banyan tree of Rajasthan

\*\* Largest Banyan tree of the world

\*\*\* Only very young leaves were not licked

the extremities of branchlets to lick the latex from every mature leaf. A gentle gnawing and/or licking at the vein furcating point of the leaf initiates the flow of latex. Once the latex begins to flow, the squirrels lick it and go to another leaf and this action is then repeated. A scar of dried latex could be seen on the underside of every licked leaf. The fresh scars are whitish, while old dried scars are dirty white or black. Presence of a latex-scar on the underside of a leaf is indicative of it having been tapped by a squirrel. This behaviour of squirrels is commonly seen in various parts of the country (Table 1).

The latex probably provides nutrition to squirrels; it seems that the squirrels procure water, minerals and organic nutrition from the latex.

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## 2. STRANDING OF A SPERM WHALE *PHYSETER MACROCEPHALUS* (LINNAEUS 1758) ON THE CHENNAI COAST<sup>1</sup>

K. VENKATARAMAN<sup>2,3</sup>, M.C. JOHN MILTON<sup>2,4</sup> AND K.P. RAGHURAM<sup>2,5</sup>

<sup>1</sup>Accepted March 07, 2005

<sup>2</sup>Marine Biological Station, Zoological Survey of India, 130, Santhome High Road, Chennai 600 028, Tamil Nadu, India.

<sup>3</sup>Email: venkyzi56@yahoo.com

<sup>4</sup>Email: drjohnmilton@gmail.com

<sup>5</sup>Email: raghurambut@yahoo.com

Whales are the most dominant marine mammals of Order Cetacea. They are mostly denizens of temperate and polar oceanic waters, but they do migrate to tropical waters for breeding and/or escaping extreme climatic conditions during certain seasons (Corbett and Hill 1992). However, not all whales that are denizens of temperate and polar oceanic waters migrate to tropical waters, e.g. the Bowhead Whale *Balaena mysticetus*, Bryde's Whale *Balaenoptera edeni* are believed to live primarily in tropical and subtropical waters all the year round. There is no evidence of their migration away from these regions. The body of the whale is protected by a thick layer of oil rich blubber beneath the skin, which acts as a thermal insulator, a store of energy for long migrations, and plays an important role for maintaining its hydrostatic buoyancy. Whales are usually found in the upper few metres of the sea, but are capable of extensive deep dives. Depending

on the presence of teeth or baleen plates, whales are classified as toothed (Odontoceti) or baleen whales (Mysticeti). Toothed whales mostly feed on fishes and cephalopods, while baleen whales mostly feed on plankton such as euphausiids, by a filter-feeding mechanism, and sometimes pelagic fishes and cephalopods (Bensam and Menon 1996).

#### Stranding of a Sperm Whale on the Chennai Coast

A Sperm Whale *Physeter macrocephalus* Linn. was stranded on the Chennai coast, behind Napier's Bridge (13°06' N, 80°18' E), in the early hours of January 21, 2002. It was a male, measuring about 995 cm long, and weighing about 3 tons. The animal had injuries throughout the caudal region, which could have been caused by the propeller of fishing boats. In general, however, the animal was in good condition with all specific characteristic features.

**Morphological features of *P. macrocephalus* Linnaeus 1758**

Enormous truncate head, almost one-third the size of the body, containing a large organ filled with spermaceti.

*Dorsal fin*: Low, small, pointed and ridge-like, followed by a series of humps up to the tail.

*Pectoral flippers*: Broad, paddle-like, small.

*Tail fluke*: Broad and notched in the middle; dark below.

*Teeth*: No functional teeth on the upper jaw; 18-27 large teeth on left side of the lower jaw.

*Blowhole*: An asymmetrical, S-Shaped blowhole on the left side of the upper anterior extremity of the forehead.

*Sexual dimorphism*: Males nearly one and a half times larger than females; end of snout squarish in males and rounded in females (Agarwal and Alfred 1999; Muthiah *et al.* 1988; James *et al.* 1993).

**REASONS FOR BEING STRANDED**

The plausible cause for being stranded is the inability of the animals to determine and avoid shallow areas, as a result of parasitic infestations of the organs connected with sonar wave perception. Hence, such whales get stranded on gently sloping beaches, murky waters and tidal sites.

**a. Interference with breathing**: Despite many impressive adaptations of whales to an aquatic environment, they still breathe in air. Apart from those killed by man, many die due to drowning. Illness, weakness and old age could lead to death, but the gravest danger faced by all cetaceans is their inability to breathe. There are numerous reports of whales of all sizes coming to each other's aid, assisting ill or injured group members to the surface where they can continue to respire. This phenomenon often becomes a reason for mass stranding in shallow waters (Bensam and Menon 1996).

Analyses of stranded whales on the British coast reveal that toothed and baleen whales, deep and shallow water species, young and old, male and female, solitary individuals and social groups, apparently healthy but injured whales

could be stranded (Watson 1988).

In most cases, the animals are still alive when they first become stranded, usually on gently shelving beaches. Post-mortem often reveals air injury, infection or debility, which probably caused discomfort, making it difficult for the whale to behave normally in deep water. Under these circumstances, faced with the risk of drowning, it would be natural for the cetacean to seek a place where it could continue to breathe, while marshalling its strength to deal with other problems (Watson 1988).

**b. Navigational errors**: Pollution and other extreme climatic conditions of oceanic waters may interfere with the communication system of the whales, thereby reducing their ability to perceive signals, resulting in navigational errors. Many whales get trapped in icebergs while migrating to their feeding/breeding grounds (Berzin 1972).

**c. Pathogens**: Like all animals, cetaceans are hosts to a number of internal parasites, such as tapeworms, hookworms, round worms and flukes. When the ancestors of the modern whale left land to take up a new life in the sea, they simply carried these lodgers with them, as their internal environments were largely unchanged. Accumulation of viruses and bacteria in the body of the whales has been proved to be an important reason for the mass stranding of pilot whales (Watson 1988).

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### 3. FURTHER NOTE ON DEVELOPMENT OF A HYBRID BETWEEN A FEMALE ORIENTAL WHITE IBIS *THRESKIORNIS MELANOCEPHALUS* AND A MALE EURASIAN SPOONBILL *PLATALEA LEUCORODIA*<sup>1</sup>

RAJU VYAS<sup>2</sup>

<sup>1</sup>Accepted September 10, 2004

<sup>2</sup>Sayaji Baug Zoo, Vadodara 390 018, Gujarat, India. Email: razoovyas@hotmail.com

Two Oriental White Ibis *Threskiornis melanocephalus* were born in May 1986 in captivity at the Sayaji Baug Zoo, Vadodara, Gujarat. One of these showed some unusual characters; it was believed to be a hybrid between a female Oriental White Ibis and a male Eurasian Spoonbill *Platalea leucorodia*, as reported by Jadeja and Vyas (1988).

The hybrid bird showed characters of both the species: large snow-white marsh bird with long black legs, a long feathery neck with black down, curved curlew-like bill, bill tip slightly spatulate, face and throat black, and tail feathers white. The hybrid bird stayed with the Oriental White Ibis most of the time.

In 1989, the hybrid bird was first observed to pair with a female Oriental White Ibis and build a nest along in the cage. The female Oriental White Ibis laid two eggs and both the hybrid male and the female Oriental White Ibis incubated them, but with no result, the birds later deserted the nest. Both the eggs, when checked, were infertile. On the basis of



Fig. 1: A hybrid between a female White Ibis and a male Spoonbill

this behaviour, it was concluded that the hybrid bird was a sterile male. This is common in higher vertebrates (Hoffman *et al.* 1978; Weir *et al.* 2000) and has been reported in many species of mammals (Iles 1960).

The hybrid Oriental White Ibis has grown well, and after fifteen years, there is no difference in appearance except that the head and anterior part of the neck are bare (Fig. 1). A light pink coloured patch developed on its flanks and under wings. The body measurements are given in Table 1.

**Table 1:** Comparison of some of the body measurements of the White Ibis and the Spoonbill with that of the hybrid bird

Body parts	Hybrid bird	White Ibis*	Spoonbill*
Wing length	380	343-370	350-395
Bill length	215	139-170	180-228
Tarsus length	130	99-115	130-165
Tail length	140	133-145	108-122

\*Source Ali & Ripley (1983); Measurements in mm

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### 4. COMMUNAL HARRIER ROOST-SITES IN MUMBAI AND AKOLA DISTRICTS, MAHARASHTRA<sup>1</sup>

ASHOK VERMA<sup>2</sup>

<sup>1</sup>Accepted July 10, 2004

<sup>2</sup>Society for Research in Ecology and Environment (SREE), Sarafa Bazar, Rekha Naanga Gali, Bharatpur 321 001, Rajasthan, India. Email: vermaasok@rediffmail.com

Six species of harriers, namely Pallid Harrier *Circus macrourus*, Hen Harrier *C. cyaneus*, Montagu's Harrier *C. pygargus*, Pied Harrier *C. melanoleucos*, Western Marsh-

Harrier *C. aeruginosus* and Eastern Marsh-Harrier *C. spilonotus* migrate to India every winter. Eastern Marsh-Harriers and Pied Harriers are restricted to east India. However,

Pied Harriers have scattered sightings from all over India (Prakash 1988; Rahmani 1988; Vyas 1992; Grimmett *et al.* 1999). A harrier ringed at Bharatpur was recovered in Kazakh; SSR (Ali and Ripley 1983), which probably indicates that part of the harrier population comes to India from Asian breeding grounds. In India, harriers generally arrive by end July, and depart for their breeding grounds generally by March. Juvenile Western Marsh Harriers, however, have been recorded wintering as late as June (Verma 2002a), and they probably go back the following year.

Harriers are interesting birds of prey as they are the only diurnal raptors that breed and roost on the ground. Among other raptors that occasionally nest on the ground, probably due to absence of nest-sites and mammalian predators, are the Common Buzzard (*Buteo buteo*), the Common Kestrel (*Falco tinnunculus*), and the Osprey (*Pandion haliaetus*) (Newton 1979; Kenyon 1947). Another interesting character of the harriers is their being communal in wintering grounds while solitary or semi-colonial in breeding grounds (Cramp and Simmons 1980; Newton 1979). They generally roost on the ground in tall grasses and reeds, but have also been recorded roosting in wetlands with floating vegetation (such as the Water-hyacinth *Eichhornia crassipes*) and bare grounds, during adverse conditions (Verma 2002a). A scarcity of safe places may force birds into a communal life, sometimes even with other species, on the few good sites that are available (Peterson 1963). The reason behind communal roosting may differ from species to species depending upon the local situation. Conservation of communal roost sites is critically important for harrier survival in winter quarters. They have been reported travelling a distance of about 40 km to join a roost (Verma 2002a).

During 2002-2003, during my visits to Mumbai and Akola, I located two harrier roost-sites. In Mumbai, an exclusive roost of marsh-harriers was identified, whereas a mixed roost of three harrier species was identified in Akola. Harrier roosts are reported from Velavadar National Park, Gujarat (Clarke *et al.* 1998), Rollapadu Wildlife Sanctuary, Andhra Pradesh (Rahmani and Manakadan 1986; Clarke and Prakash 1997/98), Alwal wetland in Secunderabad, Andhra Pradesh (Satheesan and Rao 1990; Ganesh and Kanniah 2000), Banni grasslands of Kutch (now Kachchh), Gujarat (Samant *et al.* 1995) and Keoladeo National Park, Rajasthan (Verma 2002b).

A mixed harrier roost of nearly 200 individuals was located in the grassland in Akola city (20° 43' N, 77° 04' E, 308 m above msl). The roost, comprising three species of harriers, namely Montagu's Harriers, Pallid Harriers and Hen Harriers, was identified in February 2003. The Montagu's Harriers dominated the roosting population. Of the 25 birds identified to the species level, 76% were Montagu's Harriers, 16% Pallid

Harriers and 8% Hen Harriers. Reports of marsh-harriers (around 10 individuals) roosting here was also confirmed in November 2003 (pers. comm.). Here, the grassland was spread over less than a square kilometre (average height two metres). The roost site was surrounded by crop fields, especially cotton *Gossypium* sp., on three sides, and wild vegetation (different grass and herb species) on the remaining side. The actual roost site was a treeless patch; trees found in the adjacent areas were *Buteo monosperma*, *Acacia catechu*, *Acacia nilotica*, *Prosopis chilensis*, *P. spicigera* and *Zizyphus mauritiana*.

Another roost-site was located in December 2002 in Mumbai, which was situated near the Mahul creek (19° 01' N, 72° 53' E) on the east coast of Mumbai, along the Arabian Sea, in the suburb of Chembur. Mangrove trees like *Avicennia marina* and *Excoecaria agallocha* provided pre-roost perches which they used for resting on, before settling down on the ground, their final roost. The roost site extended over a square kilometre. It was grassland dominated by perennial aquatic grass species like *Paspalum* and *Paspalum*, with an average height of 1 m. Small temporary reservoirs dotted the site teeming with water birds like waders, ducks and teals.

A stable population of Eurasian Marsh Harrier roosted here. The roost was observed in December 2002, when about 50 harriers were counted roosting here, and the population stabilized till February 2003. Birds of all age and sex classes were present. The count made in February showed 48 birds at the roost, of which 50% were juveniles, 25% females, 15% males and 10% unidentified.

### Threats

Although the Akola roost is located on government land, there is risk of heavy disturbance with the coming up of an irrigation canal in this area, which is presently under construction. The use of pesticides will increase for intensive farming, which, in turn, will drastically affect the number of harriers and their prey, especially grasshoppers. Grass cutting and burning is another threat for roosting harriers. The cutting of grass by villagers for fodder and thatch during winter in and around the roost site disturbs roosting harriers evidenced by several of them shifting from one patch of grassland to another. The local Parthi community burns the grasslands during December-February, when the harrier population stabilizes, to scan a larger area for hunting for mammals like hares, the Blackbuck *Antelope cervicapra*, the Blue Bull *Boselaphus tragocamelus* and birds, especially partridges and quails.

The roost at Mumbai is situated on the Rashtriya Chemical Fertilizers (RCF) Limited land. On the one hand grass cutting from the roost-site by locals disturbs the roosting harriers, while on the other, reclamation by the RCF itself poses a serious



danger of complete loss of roosting habitat for harriers.

An initiative by the public towards conservation of roost-sites of migrant harriers is the need of the hour. The RCF, by declaring the roost patch as a protected area, should set an example for the private sector.

Long-term monitoring of roosting populations of harriers can prove to be the best indicator of the changes in our environment.

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## 5. KHASI HILLS SWIFT *APUS ACUTICAUDA*: FIRST RECORD FROM NAGALAND AND MANIPUR, NORTH-EAST INDIA<sup>1</sup>

M. FIROZ AHMED<sup>2,4</sup>, ABHIJIT DAS<sup>2,5</sup>, VIVOSELIE MEYASE<sup>3</sup>

<sup>1</sup>Accepted July 10, 2004

<sup>2</sup>Aaranyak, 50, Samanwoy Path, Survey, Beltola, Guwahati 781 028, Assam, India.

<sup>3</sup>KNCTS, Khonoma Village, Kohima, Nagaland, India.

<sup>4</sup>Email: firoz@aaranyak.org

<sup>5</sup>Email: abhijit@aaranyak.org

The Khasi Hills Swift *Apus acuticauda* (Jerdon 1864) is a poorly known vulnerable species from Meghalaya and Mizoram in north-east India, as well as from Bhutan and Thailand (Inskipp *et al.* 1999; Brooke 1969; Kazmierczak pers. comm.). The known distribution of the species is shown in Fig. 1.

Very little information is available on the distribution, ecology and behaviour of this enigmatic species. Baker (1927) collected and observed this species in Cherrapunjee, Meghalaya (erstwhile Assam), and described its taxonomy and breeding in detail. Brooke (1969) dealt with the taxonomy and distribution of this species. There have been recent

observations on its distribution (Inskipp *et al.* 1999; BirdLife International 2001, Ahmed *et al.* 2001, 2002; Kazmierczak pers. comm.).

The Khonoma Nature Conservation and Tragopan Sanctuary (KNCTS) (25° 39' 32" N, 94° 02' 01" E, 1900-2750 m above msl), a 25 sq. km primary and secondary, temperate broadleaf and subtropical evergreen forest, is located 16 km south of Kohima city, bordering Manipur to the south. The average annual rainfall is above 2000 mm. While the maximum temperature reaches 30° C in summer (May-July) it drops below zero in winter (December- January), particularly at 2,500 m above msl.



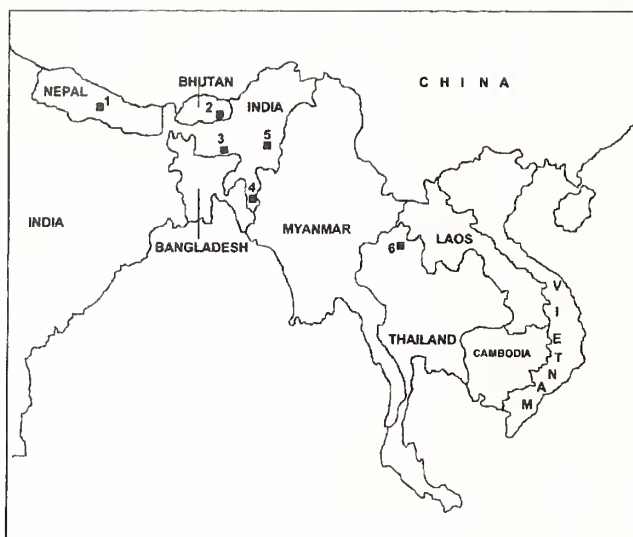


Fig. 1: Distribution of *Apus acuticauda*  
 1. Nepal; 2. Type locality: Bhutan; 3. Samdrup Zongkhar,  
 4. Cherrapunjee, 5. Blue Mountain and Tlungvel, India;  
 6. Khonoma, Thailand; 7. Chang Mai Province

The KNCTS includes part of the Dzuku valley in Nagaland through which Dzüpfü river, a tributary of Barak, flows down cutting deep gorges and cliffs in the narrow valley, providing a suitable habitat for the Khasi Hills Swift. The subtropical and temperate broadleaf forest in the Sanctuary is a suitable habitat for Blyth's Tragopan *Tragopan blythii*. The call of the Tragopan was not uncommon in the KNCTS during our visit.

On April 10, 2003, during a visit to the KNCTS, a community initiated conservation area in southern Nagaland (Fig. 1, location 5) we observed a breeding colony of the Khasi Hills Swift. At the Sanctuary Falls (25° 36' N, 94° 1' E, 2470 m above msl), on the border of Nagaland and Manipur, a series of tall cliffs with crevices, provide a suitable habitat for this threatened bird. We observed 8-10 individuals along with about 20-25 Pacific Swift *A. pacificus*. The Khasi Hills Swifts were flying within 150 m from the cliff. During our 45 minutes

of observation we saw them collecting wind blown moss, probably for nesting.

Though we did not see any breeding behaviour of the Khasi Hills Swift other than that flying close to each other, and collecting probable nesting material, we were convinced that they were in breeding. MFA has observed the breeding behaviour of this species in Cherrapunjee for a considerable time from 2001 to 2003 (Ahmed *et al.* 2001, 2002). The Khasi Hills Swift *A. acuticauda* is thus reported for the first time from the states of Nagaland and Manipur in north-east India. Khonoma is 235 km east of Cherrapunjee (25° 17.016' N, 91° 44.114' E), and 248 km north-east of Aizawl (23° 45' N, 92° 43' E), the two nearest known localities where the species was reported previously.

According to the locals, there may be other such Khasi Hills Swift breeding colonies in the gorges and cliffs of the river Dzüpfü, which originates from the Dzuku Valley, and flows into the Barak river.

The Angami Tribe of southern Nagaland has traditionally been conserving forests, even within their hill slope terrace cultivation. In 1989, the village council agreed to protect the forest of the Khonoma watershed, an important source of water for the village and its wet paddy cultivation. They constituted an independent body called the KNCTS Trust for the management of the Sanctuary. Khonoma is a traditional village and has banned hunting within the village boundary.

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## 6. FIRST RECORD OF BROWN SHRIKE *LANIUS CRISTATUS SUPERCILIOSUS* LATHAM FROM INDIA<sup>1</sup>

SUJAN CHATTERJEE<sup>2</sup> AND SUMIT K SEN<sup>3</sup>

<sup>1</sup>Accepted December 11, 2004

<sup>2</sup>DB 75, Salt Lake City, Kolkata 700 064, West Bengal, India. Email: sujan75@gmail.com

<sup>3</sup>508, Jodhpur Park, Kolkata 700 068, West Bengal, India. Email: sumitsen@vsnl.com

At Narendrapur, 17 km south of Kolkata, near the 23-acre Chintamani Kar Wildlife Sanctuary, at an altitude of 5-10 m, on May 14, 2002, at 1030 hrs, we saw and photographed two very rich-coloured Brown Shrikes *Lanius cristatus* – that appeared to have more contrast, at first glance, than the Brown Shrike we were used to seeing – sitting on a dry branch near a paddy field. Upon consulting field guides, we realised it was not like any bird cited in the available literature; it had a stronger and whiter forehead and superciliaries, upperparts reddish-brown, underparts, chin and throat white and below a deeper ochre.

We checked the illustrations and texts in the Indian field guides and they all suggested the presence of two subspecies of Brown Shrike within Indian territories, namely *Lanius cristatus cristatus* and *Lanius cristatus lucionensis* (Ali and Ripley 1987; Grimmett *et al.* 1998; Inskipp *et al.* 1996; Kazmierczak 2000; Robson 2000). We later identified the bird to be *Lanius cristatus superciliosus* which none of the Indian field guides mentioned, and it seemed that the bird was way out of its known range. References to worldwide experts on the group and their positive feedback helped us to confirm the identification.

This bird breeds in Japan in Hokkaido, Honshu, Kyushu and Tsushirna, and in the Russian Federation throughout Sakhalin. It migrates through Japan and eastern China to winter in Fukein, Kwangtung and southern Yunnan in China, in Vietnam, and in other parts of Indo-China, in the Malay Peninsula, and on the islands of Java, Sumatra, Ball, Flores and Sumba. The most westerly record is in Banguara in peninsular part of Siam (Dementev *et al.* 1954); our record could be the westernmost record in the birds' range.

The avifauna of West Bengal, Eastern India, has not been explored that well. Although many birders visit the hills of northern West Bengal, few visit the Gangetic West Bengal, the groves, the orchards or the water bodies that characterize the area.

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## 7. THE CHALLENGE OF THE *PHYLLOSCOPI*<sup>1</sup>

T.J. ROBERTS<sup>2</sup>

<sup>1</sup>Accepted June 07, 2004

<sup>2</sup>Caer Gors, Rhoscefnhir, Nr. Pentraeth, Anglesey LL75 8YU, North Wales. Email: tjrpaknatur@aol.com

The universal appeal of birds, as we all appreciate, is in their great variation in size and form, coupled with their colourful and often intricate plumage patterns; add to this the pleasure we all get from hearing bird song. What then of a whole group (genus) of small birds that look remarkably alike, are rather drab in coloration, and usually do not sing until they reach their often remote breeding grounds?

Because they are in places, not only numerous but widespread in occurrence, sooner or later, even the neophyte 'birder' tries to get to grips with their identification. Any area of enquiry if pursued long enough creates its own attendant enthusiasm, often deepening into a veritable passion, and the study of these tiny, intensely active warblers can be greatly rewarding. In most parts of the plains of India there can be

several different species of Leaf-Warblers present in the same locality. Added to this the fact that they are largely arboreal, flitting restlessly about high up in tall trees, and often largely concealed amongst the foliage, and the challenge of identification becomes especially acute.

Across the Subcontinent, there are 25 recognized different species of *Phylloscopus* (Grimmett *et al.* 1998), but I shall confine myself to just 13, all of which breed in Pakistan, where I lived for many years. Learning to recognize the calls of birds, and their songs, is always one of the first things a birdwatcher learns, as this is often the short cut to locating the birds themselves, and to knowing what is in the vicinity. The Leaf-Warblers all have rather similar contact calls, but they are usually constantly uttered while they search for their insect prey. With practice you can learn to recognize even these brief contact calls, and in some species these are quite distinct (Dymond 2003).

The next step is to try and see as much of the bird as possible, often an uncomfortable neck-stretching exercise! Does it have a single pale creamy bar across its wing coverts, or does it have two bars, the upper one often rather obscured, and if there are no wing bars, the colour of the pale superciliary stripe above the eye, and that of its breast and flanks are also useful clues. If it has two pale wing bars, look at the top of its crown. Is there a median pale streak or just two pale streaks on either side of the crown? Finally, less helpful, is the area likely of occurrence for that particular species? There are eleven species with two wing bars, but of these only four are likely to occur in the western part of the Himalaya and in the plains of Pakistan. Species such as *P. maculipennis*, *P. cantator* and *P. coronatus* are largely confined to the eastern parts of the Himalaya and adjacent lowlands. If you can afford it, try to have two or more bird books with illustrations of Asian Leaf-Warblers. Familiarize yourself with their appearance, allowing for the slight differences between each artist's interpretations of plumage colour. And, more importantly, are the illustrations of a bird in worn summer plumage or fresh winter plumage?

Now, to get down to specifics of the 13 Leaf-Warblers with which I am familiar. I will start with those five species that have no trace of any pale wing bar. Following on with those having one wing bar, and thirdly the group with two wing bars.

**1. Common Chiffchaff *Phylloscopus collybita*:** This is probably the commonest Leaf-Warbler in winter in the plains of the western part of the Subcontinent. It is distinguished by its rather drab brown plumage without any noticeable greenish tinge to its upper plumage, nor any yellowish tinge to its belly. The sub-species *tristis* differs from the European breeding Chiffchaff, which is much more olive green above,

and yellowish on the flanks. So beware of looking at European Field Guides! It does not breed within the Subcontinent, but in Pakistan in early April; birds on passage can be heard giving their full song, the rising and falling *chiff-chaff-chiff-chaff* jerky song being easily recognized. In winter, this species strangely does not call frequently, but when it does so, it is a single rather plaintive *hweet*, hence the sub-specific name, *tristis*. This species often forages around reed beds and in the open amongst low shrubs, as well as in the tops of trees, and very characteristically often makes short aerial sallies to seize a flushed insect.

**2. Mountain Chiffchaff *Phylloscopus sindianus*:** In appearance this is probably indistinguishable in winter from the Common Chiffchaff, though Brooks (1879) was the first to recognize it as distinct, from its very different call note, and consistent differences in the colour of the lower bend of the wing, showing more yellowish tones. Its contact call is a two-noted clear high pitched *tiss-yip* sometimes almost sounding three-noted *tiss-yooitt*. The writer has tape recorded singing males on their nesting ground, and there is really very slight difference between its 'Chiffchaff' song and that of the previous species. At the time, I wrote in my diary that it sounded slightly less mellifluous and more disjointed than that of *P. collybita tristis*. The song itself lasts only three to four seconds, and can be syllabified *chit-chiss-chyi-chiss-chit-chiss-chyi-chip-chit chyi*.

**3. Plain Leaf-Warbler *Phylloscopus neglectus*:** Very similar to the above two species, but distinctly smaller (about the size of a Gold Crest), with a somewhat shorter tail. It is grey brown with a quite short whitish supercilium and a trace of creamy tones along the flanks. This species is more Palearctic in distribution than any of the other species in the Subcontinent, and only rarely occurs outside of the western part of the Subcontinent. In winter, it is common in the Sind Province, less common in Punjab, and breeds in the higher mountain ranges of Baluchistan. Its song is very brief but quite distinctive, and can be syllabified *chit-chuwich-chissa* or *chit-chu-chit chit chu-twissa-twit*. It has two different contact calls, *twissa-twissa* and a harder *tak-tak* contact call, and when warning a harsher *tshak-tshak*, like a Lesser Whitethroat. Some authorities have argued that it should be treated as no more than a sub-species of *P. collybita* (Martens 1980; Johansen 1947). Recent studies based on response to playback of calls and song would confirm that it should indeed be treated as a good species.

**4. Olivaceous Leaf-Warbler *Phylloscopus griseolus*:** This is one of the easiest *Phylloscopus* warblers to recognize. Not only does it most frequently forage on the ground with a preference for rocky places, but it has a loud distinctive contact



call note, *quit-quit*. When it can be clearly seen, it is a dark olive brown on the upper parts, with quite a bright cheesy yellow supercilium, and dull yellow breast. Its winter distribution is mainly in the Deccan plateau, across Madhya Pradesh south to Maharashtra and Andhra Pradesh. It is absent from the north-western plains, with a sizeable population wintering in the foothills of the Eastern Himalaya, and migrating in spring in a westerly direction across the foothills. It breeds in the far north in high alpine regions beyond the forested zones and is also quite a common breeder in Baluchistan. The song is very brief, and at the beginning of the nesting season, only in the early morning and evening. It lasts about half to one second, starting with a high pitched barely audible whistle, followed by four or five, rapidly repeated, shorter notes, *tseep-tyi-tyi-tyi-tyi-tyi*, these notes all being in the same key. The nest which I have often found is a large domed ball, with side entrance, located usually low down in a thorny bush. It can be encountered while still on passage in the lower forested valleys of the Himalaya into mid-April, as it does not reach its northern alpine nesting areas until May, when they are free of snow.

**5. Tickell's Leaf-Warbler *Phylloscopus affinis*:** This looks closely similar to *P. griseolus*, with which it has been shown to be closely related by molecular fingerprinting. It is also very bright yellow on the supercilium, and breast, with slightly paler more greenish upper parts, and underneath more lemony yellow, less sulphurous, than in *P. griseolus*. In winter it occurs mainly in the plains and foothills of north-east India migrating westwards across the foothills in spring. A population also winters in Tamil Nadu and Kerala. In summer, it is plentiful across the alpine or un-forested slopes of the Himalaya, mainly from above 3,200 m elevation. In Gilgit I encountered many singing males on scrub-covered hillsides with *Artemesia maritima*, *Berberis lycium* and Wild Gooseberry (*Ribes grossularia*). Its contact calls, similar to those of *P. griseolus* are quite loud, short and Sparrow-like *chip-chip* and its warning calls a harsher *tak-tak*. The song lasts less than half a second and opens with a short *chip* followed by a trill of 3 to 4 up to a maximum of 6 rapid metallic notes *chip*-(pause), *whi-whi-whi-whi*. Individuals do vary this song in length and pitch. They always sing from the top of a prominent rock or bush and one male recorded, repeated its song six times over a period of fourteen seconds.

**6. Tytler's Leaf-Warbler *Phylloscopus tytleri*:** This species is often called the Slender-billed Leaf-Warbler, and its bill does look rather long and thin (Dymond 2003) but it is not enough for identification unless other Leaf-Warblers without wing bars can be compared in the same vicinity. Its upper parts tend to be quite dark olive and its breast rather white in contrast, and its supercilium is quite long and prominent and

white, not yellow as in the previous two species. Also its tail looks comparatively short. It is an arboreal bird, foraging in a broad-leaved forest in winter in the Western Ghats, and on its breeding grounds, mainly in the Western Himalaya, it breeds usually high up in conifer trees, unlike most other species which build low down in bushes or on the ground. Its contact call is weak and not often uttered, *yi-it*. The song is very brief and stereotyped, consisting of four rising and falling short phrases *kitchu-qwishu-kitchu-qwishu* and another individual *jitsu-chissyup-jitsu-chissyup*. It calls throughout the day during the breeding season as it flits about in the tree tops.

**7. Greenish Leaf-Warbler *Phylloscopus trochiloides*:** This warbler can be variable in appearance and has been divided into four sub-species. It is easier to recognize from its call notes and song. In its breeding plumage, a faint pale wing bar is visible, even sometimes traces of a second higher wing bar, but in abraded summer plumage, these are usually worn away and not visible. It has a distinct yellowish supercilium, and a greyish wash to the flanks, and the upper parts are a greyish olive green. The base of the lower mandible shows flesh tones, the tip being dark. The call note is a cheery *so-chiwee-chiwee-chiwee*, and the song is a rapid repetition of the call, a high pitched fluting *ti-psityee-psityu-psi-ti-ti-psi*. It nests in the inner higher forested parts right across the Himalaya, often in the sub-alpine Birch and scrub Juniper zone. Its nest a domed ball made largely of moss, and hidden in hollow under roots or rocks or low down in a tree hole.

**8. Bright Green Leaf-Warbler *Phylloscopus nitidus*:** This warbler is treated as a sub-species of *P. trochiloides* by many authors, but is allopatric in the breeding season with the former and much more yellow on the breast and quite a bright olive green on the back. Its supercilium is also bright yellow, and one wing bar easily discernible in fresh autumn plumage. I have come across it as uncommon in the mountainous regions of Baluchistan in May, when it was presumed to be nesting and earlier authors found them feeding fledglings in Baluchistan (Williams and Williams 1929). However, most of the population, which winters in India, breeds extra-liminally in the Caucasus and northern Iran. It was an all winter visitor to southern Sind, in the writer's experience, and its call note could be heard throughout the day, a two-noted high pitched *chiwee chiwee*. Its song is quite complicated, being a rapid sequence of warbles and short trills similar in pitch to its contact calls *tsi-tsi-tsi-tsi-che weet-chirir-chirichi-chewee-chichi*.

**9. Large Billed Leaf-Warbler *Phylloscopus magnirostris*:** This is one of the larger Leaf-Warblers, with two wing bars, and easily recognized by its preference for foraging in proximity to water even in its winter quarters, and by its distinctive call notes. There is no trace of any pale

coronal stripes, and the bill though not noticeably strong, is all dark on the lower mandible. It looks like *P. trochiloides*, but has a noticeably olive wash along the flanks, and the supercilium is quite long and yellowish white, whilst the wing bar is dull white. In flight the inner webs of the tail feathers show white. The call note carries far and is *dirtee-dirtee*, and its song, which is unusual for a *Phylloscopus*, can be heard above the sound of rushing water where it invariably nests. It consists of a very stereotyped five notes, *tee-tee tii-tu-tu*. These notes are well spaced, the first being highest in pitch, the second and third lower in pitch and shorter, with the last two notes drawn out and again lower in pitch. The song is usually repeated in bouts of 5 or 6, followed by a long interval of silence. I have heard it giving an abbreviated but distinctive version of its song in winter in the Periyar Sanctuary.

**10. Brooks's Leaf-Warbler *Phylloscopus subviridis*:**

This is one of the smaller Leaf-Warblers, with two wing bars, a long creamy supercilium meeting over the fore crown, in which area it becomes more yellow, a most helpful point in separating it from Hume's Leaf-Warbler, which occurs sympatrically. It has a less distinct but definite mid-coronal pale line, and the upper plumage is olive green with the breast pale creamy yellow, and the short tail lacks any white tips to the outer feathers. This species winters mainly in the plains and foothills of Pakistan, and breeds in the western Himalaya in coniferous forest. It breeds on the ground, in hollows under tree roots and prefers the edge of forest clearings. Its call notes are of two sorts. The most frequently uttered is a short *chwit-chwit*. Another call consists of a short elided three-noted *tissu-wee-tissu-wee*. Its song, which has often been wrongly described in many books (Ticehurst 1938; Ali and Ripley 1973), is long and complicated, continuing for three to four minutes. The song comprises widely spaced repeated sequences of short Sparrow-like *chirps*, often followed by shorter *chips* rapidly repeated, and then a sibilant rapid trilling *si-si-si-trrrrrth*. This trill at the end is soft and difficult to hear, as it often sings while foraging in the top of a conifer, and is not as clear as the drawn out "beeeze" of *P. humei* which often sings on the same tree during the breeding season.

**11. Hume's Leaf-Warbler *Phylloscopus humei*:** Very similar in size and appearance to Brooks's Warbler, being small with two wing bars, a fairly short tail and bright olive green upper plumage. On its crown there are two creamy white long supercilial lines, which also meet in front of the crown, but which in contrast to Brooks's Warbler are the same pale colour, not more yellow in front of the eye. In older publications this Leaf-Warbler was called the Yellow Browed Warbler or Inornate Warbler (Ali and Ripley 1973), but since the early 1990s it has been split into two species (Svensson 1992), with the Yellow Browed Warbler inhabiting the eastern part of the

Himalaya in the breeding season, and Hume's Warbler inhabiting the western part, as well as the adjacent plains in winter. This little warbler can only be distinguished from Brooks's Leaf-Warbler with difficulty, but it never shows the paler mesial cream line on top of the crown, which the former species possesses. Its rump is concolorous with its back, though in some lights can appear paler olive. It is not difficult to separate from the next species, Pallas's Leaf-Warbler, which not only has more prominent wing bars, which are bordered above with darker olive, and also more prominent supercilial pale streaks, which are similarly bordered above by darker olive green, but also shows a much paler lime green rump band. Its contact calls, uttered continuously when foraging are also different. The call is a two-noted *tiss-yip-tiss-yip*. The song is not so variable and shorter than that of *P. subviridis*, and starts with repeated two-noted calls *tissoo-tissoo-tissoo-tissoo* followed by a curious buzzing *s-s-s-s-s-zyip*. The buzz falls in pitch towards the end and becomes louder, lasting about 0.5 seconds. Like Brooks's Warbler it is extremely active and forages mostly high up in trees, and in Pakistan in the same localities as the former. In its breeding grounds it can be extremely common, with densities of up to four pairs per hectare (Price and Jamdar 1989). One unfinished nest I stumbled upon was a ball woven with fine grass fibres and a lot of moss, concealed under a stone on a steep slope covered with tumbled rocks; the agitated nest builder affording good views for identification.

**12. Lemon-rumped Leaf-Warbler *Phylloscopus chloronotus*:** This Leaf-Warbler is one of the easiest to identify, but first, it is necessary to offer some comment on the use of two different specific names and common names. Until 1990, they were considered the same species (Inskipp and Inskipp 1985), but studies by Alstrom and Olsson (1990) using tape playback of their recorded songs to ascertain levels of response by individual birds, suggested that Pallas's Leaf-Warbler, in their view was largely confined to China and the eastern Himalaya, and that it did not respond to played calls of *P. chloronotus* (see also Inskipp *et al.* 1996). However, they did write that the differences need more detailed analysis, and experts in Britain for example, do not appear to accept *P. chloronotus* as a separate species (Nightingale and McGeehan). Modern field guides for the Indian region now list only *P. chloronotus* (Kazmierczak and van Perlo 2000). In appearance, this is also a small, short-tailed Leaf-Warbler, with two prominent creamy wing bars, two creamy supercilial stripes, bordered above and below with darker olive green bands, and most conspicuously, a broad pale lime green rump band, as well as a conspicuous mid coronal or mesial pale creamy line. I have found that this extremely active bird may forage for as long as an hour in the tops of trees, without ever



opening its wings or fluttering out to catch an insect, and thus never revealing its pale rump patch. It is very much an arboreal species preferring to hunt in tall trees, and whenever a mixed species hunting guild passes through its breeding territory, joining the throng in their search. In winter it does not migrate far down into the plains, remaining often in the foothills, and in Pakistan, I have encountered it in December in Gilgit. These birds build their nests high up in trees, usually conifers, and are very difficult to locate. Both in winter and summer they call in bouts, falling silent for long intervals, and it is a not very loud, short *tsip*. The song is usually given from high up in the top of a favourite tree. It is a long and complicated sequence of two-noted chirping notes interspersed with more Sparrow-like chirrups, and rapid titters or trills. It is surprisingly loud for the size of the bird, and each individual will use different combinations or sequences of these phrases. One male tape recorded, sang non-stop for four minutes in late June, when the female was presumed to be incubating. It can be syllabified *titsu-titsu-tissyip-tissyip-tissyip-titititti-t-t-t-syisu-syisu-titertitertiter tissyip-tissyip-titu-titu-tititit-t-t-t*.

**13. Western Crowned Leaf-Warbler *Phylloscopus occipitalis*:** This is by far the commonest Leaf-Warbler in the

western Himalaya, and can be described as literally swarming in the forests from about 1,980 m up to the limit of the tree line at 3,200 m. In winter it migrates as far south as peninsular India, from Gujrat to Kerala, and passing rapidly north through Pakistan in the spring. It is a largish Leaf-Warbler with two wing bars, and a distinctive head pattern with two pale creamy supercilium lines above the eyes, a darker olive green crown, divided in the middle by a greyish white mesial or mid coronal line, and with the upper back or mantle showing a greyish wash. The upper plumage is otherwise greenish olive and the pale whitish belly shows yellow streaks in fresh plumage with some grey along the flanks. It nests on the ground or low down in a tree hole, and the nest is usually located more than an arm's length from the hole opening. The writer had a summer cottage in the Murree Hills at about 2,500 m elevation. And two pairs bred in the gable end of our stone built cottage; one each year in a weep hole near the foundations, and the other under the roof eaves. I estimated the nesting density in that patch of forest as roughly 0.1 per hectare. They call incessantly during the day, a two-noted *chiwee-chiwee* or by-syllabic *wichee-wichee*. Its song is a variation of the call note, being a rapidly repeated but elided version of the call notes, *chwi-chwi-chwi-chwi*.

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## 8. BROAD-TAILED GRASS-WARBLER *SCHOENICOLA PLATYURA* IN NASHIK, MAHARASHTRA<sup>1</sup>

BISHWARUP RAHA<sup>2,3</sup>, RAMESHWAR SARDA<sup>2,4</sup>, VIRAL K. MISTRY<sup>2,5</sup>

<sup>1</sup>Accepted September 10, 2004

<sup>2</sup>Nature Conservation Society of Nashik 13, Hemant Vihar, Veer Savarkar Nagar, Off Gangapur Road, Nashik 422 005, Maharashtra, India.

<sup>3</sup>Email: wolfajay@hotmail.com

<sup>4</sup>Email: rds@deshdoot.com

<sup>5</sup>Email: mistryviral@gmail.com

The Broad-tailed Grass-Warbler *Schoenicola platyura* is found in the damp high montane grasslands of the Western

Ghats and the Nilgiri hills, occurring largely in Karnataka, Kerala and Tamil Nadu (BirdLife International 2001). The



species is considered to occur in the Eastern Ghats of Andhra Pradesh (Price 1979; Grimmett *et al.* 1998; BirdLife International 2001) and more recently has been recorded from Lonavala in northern Maharashtra (Singh 2002). Except for its recent sighting in Lonavala, this species has not been recorded north of Karnataka. In this note, we present the details of our recent sightings in Nashik.

While watching birds on the slopes of Ramshej, a hill about 15 km from Nashik city, adjacent to the Peth Road near Ashewadi village, a Broad-tailed Grass-Warbler was sighted in February 2003, its identity confirmed from Grimmett *et al.* (1998). Subsequently, between August 1-15, 2003, the bird was seen on ten occasions in the same locality. During this period, the bird was videotaped and photographed; it was again seen in the locality on December 23, 2003.

The grassy slopes of Ramshej, where the Broad-tailed Grass-Warbler was sighted, comprise a mixed growth of *Heteropogon contortus*, *Cymbopogon martini*, *Themeda* spp., *Cynodon dactylon*, and *Aphida mutica* grasses. The grassy slopes were also interspersed with sparsely growing and widely scattered *Bombax ceiba*, *Butea monosperma*, *Wrightia tinctoria*, *Carrisa conjesta* and *Lantana camara*, whose average height was less than 2 m. The general area surrounding Ramshej is basically grassland contiguous with other hills. These grasslands remain dry for most of the year, except during the monsoon months of July-September.

On all occasions when the Broad-tailed Grass-Warbler was sighted, it was seen singing from two regular perches, one of which was a dwarf *B. ceiba*, about 1.5 m in height, and the other was an overhanging electricity supply cable. It is

interesting to note that in 1881 Butler observed the bird perching even on telegraph wires. At times, the bird was observed to circle overhead, fanning its tail and fluttering its wings in a peculiar manner, singing continuously all the time, as if on display. It was regularly seen visiting a particular patch a few metres away from the dwarf Silk Cotton tree. Only once while this particular bird was perched on the Silk Cotton tree, did we sight another bird, which flew out of the same grass patch and flew a few metres away. No effort was made to search the grassy slopes for nests.

Although, Ali and Whistler (1935-1937) describe the species as an "inveterate skulker", except in the early mornings when it was seen "clambering up the grass stems to exposed situations", our observations are more in line with the observations of Ali and Whistler (1935-1937), BirdLife International (2001), and Ferguson and Bourdillon (1903-1904), who found the species to be "far from shy" and "not a shy bird", that "may often be seen perched on the top of a bush or tuft of grass". Although, the species is considered to be a seasonal visitor in many localities, being capable of altitudinal movements (Birdlife International), our sightings of the bird in February, August and December indicate that the species, as indicated by Ali and Ripley (1987), could possibly be a resident in Nashik.

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### 9. PATERNAL AGGRESSIVE BEHAVIOUR TOWARDS OFFSPRING IN PURPLE-RUMPED SUNBIRD *NECTARINIA ZEYLONICA*<sup>1</sup>

ANAND PRASAD<sup>2</sup>

<sup>1</sup>Accepted May 31, 2004

<sup>2</sup>Middlewood, Roeburndale West, Lancaster, LA2 9LL, UK. Email: [anandprasad@phonecoop.coop](mailto:anandprasad@phonecoop.coop)

On August 21, 2003, at Candolim, Goa, from my balcony, I watched two young Purple-rumped Sunbirds *Nectarinia*

*zeylonica* leave their nest for the first time. Their first flight was clumsy and amusing to watch, and I was eager to observe

their first experience of the big, wide world. I was therefore surprised, upon discovering the location of one of the newly-fledged youngsters, which was identified by its yellow throat, to witness the following scene. The female, which was perched close to the juvenile, was calling vigorously and the juvenile was begging for food. The male landed close by and there was some wing fluttering and display, and much calling from the adults before the female flew off. The adult male then proceeded to peck vigorously at the body of the juvenile and continued violently until the juvenile, whilst still clinging to the branch, dropped upside down into a hanging position, and froze as if dead. I was sure the bird was actually dead, but the attacks on the apparent corpse slowed down and eventually stopped, and then the male flew off. This happened very quickly and I had no time to react, and was also unsure whether to interfere. I then waited to watch the behaviour of the female and to see if the juvenile was dead or unconscious. After a few minutes, the juvenile revived and it seemed that it had been feigning death, as the blows had all been to the body which I had thought unlikely to cause unconsciousness.

The juvenile was obviously hesitant to start calling again after this treatment but slowly gained confidence and began to resume begging for food. The female appeared and fed the juvenile, which appeared completely unharmed. The male also soon returned to the juvenile, which was at first very nervous, but quickly resumed its normal begging behaviour. Although I did not see the male feeding the juvenile, no more aggressive behaviour was noted.

The only explanation for such behaviour was that the female was calling vigorously, on the onset of fledging, presumably to inform the male that a new phase of parental care had now started and that not only would it need to bring food to the nest, but that the fledglings would need constant locating, being warned of dangers, feeding and all the other activities involved with rearing the juveniles to complete independence. It is not preposterous to assume that the male may have got the calls from the female instigating the next phase of parental behaviour, confused it with that of courtship, and this therefore triggered an aggressive territorial display from the male towards a rival.

## 10. RANGE EXTENSION OF JUNGLE MYNA *ACRIDOTHERES FUSCUS FUMIDUS*<sup>1</sup>

SUJAN CHATTERJEE<sup>2</sup>, SUMIT K. SEN<sup>3</sup> AND DIPANKAR GHOSE<sup>4</sup>

<sup>1</sup>Accepted October 28, 2004

<sup>2</sup>DB 75, Salt Lake City, Kolkata 700 064, West Bengal, India. Email: sujan75@vsnl.net

<sup>3</sup>508, Jodhpur Park, Kolkata 700 068, West Bengal, India. Email: sumitsen@vsnl.com

<sup>4</sup>WWF-India Sikkim Prog. Office, Deorali, Near Forest Secretariat, Gangtok, Sikkim 737 102, India.

Initially aiming to generate a check-list of the birds of Kolkata, we have been studying the avifauna of Kolkata since 1990; since early 2000, we also photographed the birds. On August 3, 2001, at 1100 hrs, a Jungle Myna *Acridotheres fuscus* was sighted at Eden Gardens in the heart of the city of Kolkata; one of our members photographed it. Not much attention was paid to this sighting, as the Jungle Myna is a fairly common bird in Kolkata. A few months later, while sorting the photographs, we chanced upon this particular photograph; the bird looked like a Jungle Myna, but a closer look revealed some differences

in coloration of the bird. The bird had an almost black head and a very dark slaty grey on the back. It had an orange eye-ring similar to the nominate species *Acridotheres fuscus*, but what was most striking was that it had a dark slaty grey vent instead of pale cream colour vent. After consulting the field guides (Ali and Ripley 1987; Grimmett *et al.* 1998; Kazmierczak and van Perlo 2000 and Robson 2000), it was identified as the eastern race of Jungle Myna *Acridotheres fuscus fumidus*. The bird appears to exist very far from its range, which is Nagaland, eastern Assam and Arunachal Pradesh.

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# 11. SOME OBSERVATIONS ON THE GEOGRAPHIC VARIATION OF MIXED-SPECIES BIRD FLOCKS IN SRI LANKA<sup>1</sup>

EBEN GOODALE<sup>2</sup> AND SARATH W. KOTAGAMA<sup>3</sup>

<sup>1</sup>Accepted February 28, 2005

<sup>2</sup>Graduate Programme in Organismic and Evolutionary Biology, University of Massachusetts, Amherst 01003-5810, USA.

CURRENT ADDRESS: Department of Zoology, University of Colombo, Colombo 3, Sri Lanka. Email: eben.goodale@gmail.com

<sup>3</sup>Department of Zoology, University of Colombo, Colombo 3, Sri Lanka. Email: fogsl@sl.lk

Mixed-species bird flocks are a prominent feature of the avifauna of the Indian subcontinent. Many species participate in flocks, in at least some of their range, as frequently noted in the species accounts by Ali and Ripley (1987). In some areas, such as the Sinharaja World Heritage Reserve in Sri Lanka, the majority of common species are more readily observed inside of mixed flocks than outside of them (Kotagama and Goodale 2004). Descriptions of flock systems in different parts of the Subcontinent are now beginning to accumulate (Partridge and Ashcroft 1976; MacDonald and Henderson 1977; Robin and Davidar 2002; Kotagama and Goodale 2004).

One limitation in most flock studies is that they are conducted at one field site (see, however, Robin and Davidar 2002 for a comparison between teak plantations and moist deciduous forest). The question then arises as to how representative these studies are of flocks in the geographical region, where 'region' may be defined at different spatial scales. In Sri Lanka, flock systems have been described at montane elevations (approximately 2000 m above msl, Partridge and Ashcroft 1976), and at low elevations in the wet-zone (approximately 500 m above msl, Kotagama and Goodale 2004). The kinds of flocks that occur at intermediate elevations are hitherto unknown.

We undertook a short-term study to investigate altitudinal variation, within a 20 km radius area, around our main research site in the Sinharaja World Heritage Reserve, where flock studies have been going on since 1981 (Kotagama and Goodale 2004). A total of 10 transects were placed in the Sinharaja Reserve, the Delwala Proposed Forest Reserve and the Walankanda Forest Reserve. Transects were placed inside forests with continuous canopy, either in primary forest, or in secondary forest, logged in the 1970s and 1980s and was now at least 15 m in height. Transects were positioned at a distance of at least 250 m, and at different elevations – four between 400-600 m above msl, three between 600-800 m, and three between 800-1100 m. Each transect was 0.75 km long, except for one 0.5 km transect in the Walankanda Reserve, where bamboo thickets made walking difficult.

We visited each transect for at least three and up to six consecutive days, spending at least three days without rain

at each transect, for a total of 42 days. We started observations at 0630 hrs and walked up and down the transect till 1630 hrs, with scattered breaks. A flock was not included in the analysis, if another flock had been seen earlier during the day within 250 m. We, however, counted flocks that were seen in the same 250 m area on separate days. These flocks undoubtedly contained some individuals from earlier flocks; however, as flocks re-form every morning we consider them independent observations (see also discussion of independence in Kotagama and Goodale 2004). Visits to the different transects were scattered between January 29 and June 25, 1998. During extensive fieldwork in the Sinharaja Reserve, we found seasonal variation in flock composition and size to be low (Kotagama and Goodale 2004).

A majority of the flocks encountered (42 of 58) were similar to flocks previously described by us from the Sinharaja Reserve, as they centred around the gregarious Ceylon Rufous Babbler (*Turdoides rufescens*) and included a high number of species and individuals (an average of 10.4 species and 31 individuals). In particular, these babbler-led flocks included three of Sri Lanka's endemic and vulnerable species (BirdLife International 2001) – 23 flocks included Ashy-headed Laughingthrush (*Garrulax cinereifrons*), 17 flocks included Ceylon Starling (*Sturnus albofrontatus*), and 15 flocks included Red-faced Malkoha (*Phaenicophaeus pyrrhocephalus*). At least two of these three species were seen in 18 babbler-led flocks, and the three species were found in such flocks in all the forest reserves. However, these species were rarely involved in flocks without babblers (laughingthrushes were found in one such flock, malkohas and starlings in none).

Flocks without babblers were found primarily on the transect at the lowest elevation (all of the six flocks found on the 400 m transect in the Delwala Reserve), and on the transect at the highest elevation (five of the eight flocks found on the 1100 transect near the former Morningside Estate in the eastern sector of the Sinharaja Reserve). Such flocks were substantially smaller than those that included babblers (averaging 7.4 species and 15 individuals; comparison to babbler-led flocks, two sample t-tests,  $t_{56} = 2.69$ ,  $P < 0.01$  for species, and  $t_{56} = 4.37$ ,  $P < 0.001$  for individuals). At the lowest



elevation transect, babblers were not present inside or outside flocks, during our visit. The one constant in flocks at this transect was the presence of Greater Racket-tailed Drongos (*Dicrurus paradiseus*), which were in every flock, and for the entire observation period. At the highest elevation transect, flocks similar to the montane system co-existed with the larger babbler-led system. These flocks were led by the Ceylon White-eye (*Zosterops ceylonensis*) and the Grey-headed Flycatcher (*Culicicapa ceylonensis*), the two most numerous species in the montane system (Partridge and Ashcroft 1976). Three times we saw these montane-like flocks join a babbler-led flock and then split away less than half an hour later.

The observation that several of the vulnerable species that participate in flocks were found almost exclusively with Ceylon Rufous Babblers, indicates the importance of babblers for other birds that associate with them. Babblers have all the characteristics of 'nuclear' species in flocks (*in sensu* Moynihan 1962, Hutto 1994); they are found in most flocks, are rarely found outside of them, and lead the flocks (Kotagama and Goodale 2004). Other species are attracted to the playback of the calls of this species (Goodale and Kotagama 2005b).

Observations of flocks without babblers at the lowest elevation transect suggest that the Greater Racket-tailed Drongo can also be considered a nuclear species. Drongos are frequent members of babbler-led flocks and are rarely found outside flocks. However, their role in flocks is not as clear as that of the Ceylon Rufous Babbler, because they lead fewer flocks than do babblers, and also are inter-specifically aggressive, sometimes stealing food from other species (King and Rappole 2001). We have previously argued that drongos may be beneficial to other species because they make reliable and sensitive alarm calls (Goodale and Kotagama 2005a), and that they should be considered nuclear species, because like babblers, their calls attract other species in playback trials (Goodale and Kotagama 2005b). The observations on the lowest elevation transect support this idea, by demonstrating that mixed flocks form around drongos, when babblers are absent.

Observations at the highest elevation transect demonstrate that montane-like flocks may co-exist with lowland flocks in areas of intermediate elevation. One question raised by these observations is whether species prefer to participate with one flock system more than the other. We found that the smaller sized species associated with the

montane-like flocks, the nine most frequent species in them (present in at least two of five flocks), averaged 23.8 g, whereas the eight most frequent species in the babbler-led flocks at the same transect (present in at least two of three flocks) averaged 50.1 g (two sample t-test,  $t_{14} = 2.25$ ,  $P < 0.05$ ; weight data from Ali and Ripley 1987 and, if not available, estimated from closely related, similarly sized species). Separate flock systems with birds of different sizes have also been described from New Guinea (Bell 1983). Such a phenomenon might arise if birds prefer to associate with other species that share the same predators, particularly since the species' propensity to flock is associated with their vulnerability to predation (Thiollay and Jullien 1998).

While this study shows that certain phenomena, such as flocks centred around drongos, and separate flock systems co-existing in intermediate elevations exist, our understanding of how flocks vary by elevation would clearly be expanded by further sampling in different areas and over longer time intervals. Similar studies should also determine how land-use patterns affect flocks. Management plans that target a flock system, or a nuclear species like the Ceylon Rufous Babbler, may benefit several threatened species that participate in flocks, such as the Ashy-headed Laughingthrush, the Red-faced Malkoha, and the Ceylon Starling. A few studies in the neotropics have shown that participants of flocks may be particularly vulnerable to disturbance, and sometimes the whole flock system may disappear (Thiollay 1992; Stouffer and Bierregaard 1995). Such studies are needed on the Indian subcontinent to develop community-wide conservation strategies.

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## 12. ADDITIONS TO THE AVIFAUNA OF GOA, INDIA<sup>1</sup>

S.D. BORGES<sup>2,3</sup> AND A.B. SHANBHAG<sup>2,4</sup>

<sup>1</sup>Accepted June 07, 2004

<sup>2</sup>Department of Zoology, Goa University, Taleigao Plateau, 403 206, Goa, India.

<sup>3</sup>Email: sonalidbr@yahoo.com

<sup>4</sup>Email: abshanbhag@yahoo.com

The first report on the birds of Goa in 1976 recorded 154 species (Grubb and Ali 1976). Subsequently Saha and Dasgupta (1992) raised the number of species to 208. All the reports thus far were based on opportunistic surveys, mostly of forested regions, none of them exceeding 16 days. In 1996, the ecological research on wetlands and waterbirds of the state was initiated at three freshwater bodies (Walia and Shanbhag 1996; Shanbhag *et al.* 2001). Around the same time, Lainer (1999a, b) reported 382 species, increasing the number of avian species of Goa to 174.

However, not much was known of the ecology and bird fauna of estuarine wetlands in the state. The Sálím Ali Bird Sanctuary, the only one of its kind in the state within the estuarine belt, though notified in 1988, was not an exception. Therefore, a detailed three year study was initiated to understand the ecology of the Mandovi estuarine wetland in general and its avifauna in particular (Borges 2003). In the course of this study, encompassing the deltaic islands of Chorao, Diwar, Chorao Minor and the estuarine banks of Ribandar (Fig. 1), observations were carried out by boat as well as on foot, using 12 x 25 binoculars and a 15-45 x 60 spotting scope. Birds were identified using standard field guides (Sonobe and Usui 1993; Ali 1996; Grimmett *et al.* 1998).

During the study, a total of 151 species, both resident and migratory birds were recorded, eight of which were new sightings or confirmations for the Goa region.

These eight species were sighted on more than one occasion. This paper records sightings, microhabitat utility and behavioural attributes of these species.

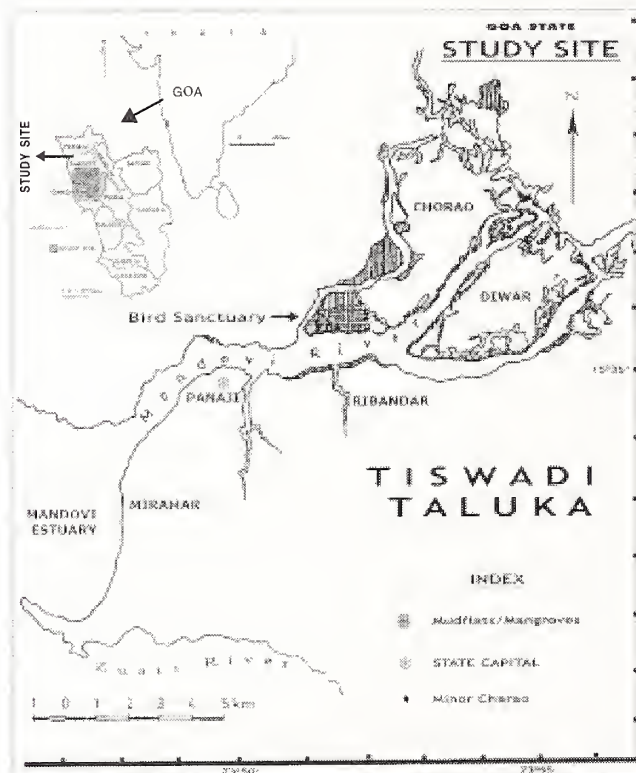


Fig. 1: Map of the study site



### 1. **Little Bittern** *Ixobrychus minutus*

Some bitterns, slightly smaller than the chestnut bittern frequented the estuarine islands during the monsoon of 1999 and 2000. The distinct greyish black crown and brown scapulars confirmed that the birds were female little bitterns. A lone female bird was sighted on the northern side of Chorao Minor on June 17 1999, and again on September 27, 1999. Two more birds were encountered, one each in the driest region of the exposed mudflat of Chorao Minor (August 29) and Chorao (September 5). In 2000, three female Little Bitterns were flushed from reed-beds of Chorao in August, while another was observed at Chorao Minor in September. The solitary female was seen again in December at Chorao Minor. Three more females were flushed from the reed-beds at Chorao a month later.

In November 2000, a similar sized bittern was seen crouching amongst the pneumatophores and stilt roots in the interiors of the Bird Sanctuary. Initially mistaken for a male Yellow Bittern *Ixobrychus sinensis*, it was confirmed to be a male Little Bittern, owing to its deep black back, and the absence of a dark strip along the centre of the neck. Two more male little bitterns were sighted at Chorao Minor in February 2001.

Little Bitterns are known to breed in the tall reed beds of Kashmir and Assam during the monsoon (Holmes and Parr 1989). Although there have been a few stray sightings elsewhere, only a couple of these sightings have been from as far down as coastal islands off Mumbai (Abdulali and Grubb 1966), and southern Karnataka (Grimmett *et al.* 1998). Sporadic sightings of a few little bitterns in the estuary numbering not more than three per encounter may be construed as their being stranded break-away exploratory flocks, or even failed wintering attempts by small non-breeding populations towards the west coast of the country.

### 2. **Black Bittern** *Dupetor flavicollis*

Two male birds were sighted perched on fishing stakes, one at Ribandar and one at Chorao Minor in June 5, 1999 and November 21, 1999 respectively. On December 21, 1999, two more birds were observed perched on stilt roots at Chorao Minor while a lone bird was sighted on a mound of stones along the river's edge at Chorao. The bird was seen yet again in January and March 2000, at Chorao and Ribandar respectively. In August 2000, three black bitterns were noticed at Chorao while one bird was seen at the same site in November. Two birds were observed at Chorao Minor in December 2000 and one bird each was sighted at Ribandar, Chorao and Chorao Minor in January 2001.

The Black Bittern has been described as a widespread, resident throughout India with scattered distribution (Ali 1996). It has been observed to breed in Kerala (Neelakantan 1956), and move towards Tamil Nadu during the non-breeding

season (Joshua and Johnsingh 1985). Considering its distribution all along coastal Kerala and Karnataka, on the west coast of India, its sighting in the coastal belt of Goa only amounts to marginal extension in the range of the species.

### 3. **Black Ibis** *Pseudibis papillosa*

Three of these red-capped black birds with white shoulder patches were observed feeding actively on the insects and crustaceans on the exposed mudflats of Chorao Minor and Ribandar on April 21, 1999. At Ribandar, one of the birds was seen jabbing at a mudskipper, *Boleophthalmus* sp. In April 2000, two Black Ibises were sighted on the Ribandar mudflats, while four birds were recorded at Chorao Minor. The latter were present for approximately 20 minutes and took off en bloc in a north-easterly direction. Exactly a year later, two more birds of the species were sighted at Ribandar.

The Black Ibis, a resident throughout the Indian peninsula is a regular visitor to the better-watered parts of Maharashtra (Jamdar and Shrivastava 1990). As Goa neither lacks the habitat requirements for Ibises in general (Lainer 1999a; Shanbhag *et al.* 2001), nor is it too far flung from Maharashtra, the regular seasonal sightings of a few individuals of the species can be taken as probable attempts towards its range extension.

### 4. **Jack Snipe** *Lymnecryptes minimus*

On the evening (1500 hrs) of April 12, 2000, a bird each of the species was flushed out at two separate locations from the tall reed swamps adjoining the mudflat at Chorao. The birds were smaller than other snipes, had shorter and stouter bills and a split supercilium. Both birds were flushed during a foot trail through the northern side of the marsh, at a distance of roughly 40 m from each other. These sightings confirm the earlier 'unconfirmed report' (Lainer 1999b), as to the possible occurrence of the species in the state.

### 5. **Red Knot** *Calidris canutus*

Two sandpipers slightly larger than Little Stints were observed feeding actively in mixed flocks of waders. The birds were observed to feed on larger benthic polychaetes, particularly nereids, on the mudflats of Chorao on October 25, 1999. The birds were confirmed to be Red Knots owing to their stout stature, short straight bill and dull grey upperparts. In the year 2000, a single bird each was sighted in January on the Ribandar mudflat, and in March and November at Chorao Minor. On all three occasions, the birds were feeding actively on the algae and the wet sediment close to the surf line, probably on crustaceans. However, at all the sites the birds were present for a brief period of less than 45 minutes.



## 6. **Pied Avocet *Recurvirostra avosetta***

This conspicuous pied wader with a slender, but prominently upturned bill, was observed feeding in the shallow water below the surf line at Chorao Minor on April 21, and May 19, 1999. The birds fed by continuously moving their heads from side to side with half the bill immersed in water, a characteristic of avocets. In December 1999, two Pied Avocets were seen feeding actively in the shallow waters of Diwar at about 1600 hrs. In April 2000, a lone Pied Avocet was seen foraging at Chorao Minor, amidst other waders.

In India, there are records of Red Knots and Pied Avocets wintering in parts of Kerala (Namassivayan and Venugopal 1989), and on the coast of Tamil Nadu (Balachandran 1995). Considering the contiguity of the long coastline of Kerala/ Karnataka with Goa, the regular sightings of a few Red Knots and Pied Avocets along with other waders may be logically acceptable, as tropical estuarine wetlands are known to be of great dietary significance to migrant waterbirds (Wootton 1997). Hence, the occurrence of Red Knots and Pied Avocets on the Mandovi estuarine mudflats is not surprising, as the sites are rich in benthic invertebrates (Borges 2003). The regular sighting of a few avocets particularly in summer indicates that the Mandovi estuarine mudflats are probably being used as potential stopover sites by the species.

## 7. **Great Stone-Plover *Esacus recurvirostris***

A single bird was sighted consistently for a period of three months from November 2000 to January 2001 in the deeper reaches of the bird sanctuary. The shy wader with large eyes and a stout bill was observed to feed on mud crabs, *Grapsus* sp. The bird was quick to dart away into the thick mangrove vegetation when confronted with even the slightest disturbance.

The Great Stone-Plover is known to inhabit a variety of habitats ranging from semi-dry pockets of the Thar

desert (Sangha 2002) to the coastal mudflats of Kerala (Nameer 1992) and Tamil Nadu (Balachandran 1995). The sighting of the Great Stone-Plover at Chorao was an extremely rare occurrence, considering that only one bird was sighted during the entire study period of three years. The species is described to be 'resident subject to local movements' with one of the breeding stretches across Karnataka (Grimmett *et al.* 1998). As the bird sighted did not show any indication of injury, it could be a case of sheer stray vagrancy.

## 8. **Desert Wheatear *Oenanthe deserti***

The sandy buff-coloured sparrow-sized birds were observed, perched in small flocks, on electric wires, overlooking freshly harvested paddy fields at Chorao and Diwar in September 2000. The birds were confirmed as Desert Wheatears by their black throats, buff white underparts and blackish brown wings and tails. While seven birds were counted at Chorao, 12 of them were sighted at Diwar. At both the sites, the flocks consisted of both the sexes. At Chorao, the birds remained undisturbed by the paddy-thrashing activity nearby, regularly alighting on the ground to pick the insects.

Desert Wheatears affect habitats ranging from dry scrubland to canal irrigated agricultural plots. The species, a regular winter visitor to central Maharashtra and north Andhra Pradesh, tends to winter even in Madras (Santharam 1989). As such, the species may have strayed into the state and having found suitable conditions, stayed on, as was the case with the Great Stone-Plover.

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### 13. HOLE-NESTING IN CAPTIVE *INDOTESTUDO TRAVANCORICA*<sup>1</sup>

MADHURI RAMESH<sup>2</sup>

<sup>1</sup>Accepted September 10, 2004

<sup>2</sup>Centre for Herpetology, Madras Crocodile Bank, Mamallapuram, P.O. Bag 4, 603 104, Tamil Nadu, India.

Email: madhurir@hotmail.com

The Travancore Tortoise *Indotestudo travancorica* is a medium-sized testudine endemic to the Western Ghats of India. Auffenberg (1964) reported the breeding season as extending from November to January, but other authors believe that this tortoise may breed at other times of the year (Vijaya 1983; Moll 1989; Sane and Sane 1989; Das 1991). While nesting the female lays 1-3 eggs on the ground or in a shallow nest of leaf litter, and hatchlings are obtained in June (Das 1991).

In India, the Centre for Herpetology, Madras Crocodile Bank has the only captive breeding group of this species (Andrews and Whitaker 1993), consisting of three males and six females (Table 1; individual animals could be clearly

distinguished by natural markings on the carapace, and were assigned an alphabetic identity code). Enclosure utilization (Ramesh 2002) and breeding behaviour of the Travancore Tortoise was observed from July to December 1999. Contrary to existing literature, hole-nesting was observed during the study period, and has been reported here for the first time.

**Table 2:** Measurements of eggs of captive *Indotestudo travancorica* at the Madras Crocodile Bank

Clutch	Eggs	Av. L $\pm$ SD	Av. W $\pm$ SD	Av. Wt $\pm$ SD
<b>June 1999</b>				
1	5	44.52 $\pm$ 3.02	36.45 $\pm$ 0.59	-
2	5	48.06 $\pm$ 1.2	37.29 $\pm$ 0.83	-
3	3	49.18 $\pm$ 0.98	39.25 $\pm$ 0.89	-
4	2	44.22 $\pm$ 0.22	35.6 $\pm$ 1.2	-
<b>December 1999</b>				
1	3	45.77 $\pm$ 1.13	35.91 $\pm$ 1.12	34.9 $\pm$ 2.85
2	4	49.01 $\pm$ 0.87	39.41 $\pm$ 0.42	44.5 $\pm$ 1.87
3	3	44.73 $\pm$ 0.49	37.08 $\pm$ 0.31	36.03 $\pm$ 0.74
4	2	47.4 $\pm$ 1.1	36.7 $\pm$ 0.45	38.1 $\pm$ 2.1
5	3	46.47 $\pm$ 3.54	37.5 $\pm$ 0.23	38.06 $\pm$ 1.18
6	3	48.47 $\pm$ 2.72	38.77 $\pm$ 0.45	43.43 $\pm$ 1.44
7	2	42.22 $\pm$ 0.43	36.18 $\pm$ 0.27	33.05 $\pm$ 0.45
8	2	53.1 $\pm$ 0.4	42.38 $\pm$ 0.17	57.1 $\pm$ 0.1
9	3	45.3 $\pm$ 0.75	36.5 $\pm$ 0.06	36.07 $\pm$ 0.88
10	4	44.39 $\pm$ 1.4	37.5 $\pm$ 0.51	36.25 $\pm$ 2.17
11	3	50.48 $\pm$ 0.83	39.62 $\pm$ 0.51	47.3 $\pm$ 1.51

**Table 1:** Measurements of the captive breeding group of adult *Indotestudo travancorica* at the Madras Crocodile Bank

Code	Sex	CCL	CCW-F	CCW-R	PL	PW	WT
SC	M	35	28.5	26	24	21.5	4.25
ST	M	39	30.5	28	23	23	4.5
B	M	26	22.5	20	18	16	2
Y	F	25	20	19	17.5	16	2
L	F	31	26	23	21.5	19	3
CL	F	28	21.5	21	17	17	2.75
D	F	30	26	24	21.5	19.5	3
P	F	26	22	19	19	15.5	2.75
PH	F	28.5	24	22.5	19.5	17	2.5

CCL: curved carapace length, CCW-F: curved carapace width (front), CCW-R: curved carapace width (rear), PL: plastron length, PW: plastron width; all in cms. WT: weight (kg), M: Male, F: Female.

Av. L: Average Length, Av. W: Average Width, Av. Wt: Average Weight

Fifteen clutches of eggs were found during the study period, first in June 1999 and later in December 1999 (Table 2). They had been laid near the roots of trees or shrubs, and in areas that had scanty leaf litter cover (c. 2 mm; average depth of litter in enclosure = 53.45 mm). The eggs had been deposited in a chamber dug in the ground and covered up with earth. Mean nest dimensions were 13.6 cm (depth) x 8.5 cm (width). On candling the June clutches, most eggs were found to be infertile or dehydrated, some had rudimentary, but disintegrating embryos. The only egg with an intact embryo was monitored in the laboratory, but after 46 days, it cracked open to reveal a fully-developed, rotting embryo. Oviposition was observed for the first clutch laid on December 4, 1999 at 1735 hrs, and the behavioural sequence is given below:

0 mins – (Female was seen sitting near the root of a tree throughout the day.) Female cleared leaf litter away with hind legs using small, slow movements.

09 mins – She excavated a hole and lowered her posterior

end towards it. The carapace covered the hole completely, and hence actual oviposition could not be seen.

20 mins – She moved the hind legs alternately towards the tail, covering the eggs with earth and compacting it by pressing with hind legs. This continued for another 29 mins.

50 mins – She finished covering the nest and walked away. The nest was excavated and measured. Four white, hard-shelled eggs covered by a thin layer of mucus were found along with an older desiccated egg.

Substrate temperature recorded at 1700 hrs was 22.9° C.

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#### 14. FURTHER NOTES ON BREEDING COLOUR IN MALE *CALOTES VERSICOLOR*<sup>1</sup>

SATISH KUMAR SHARMA<sup>2</sup>

<sup>1</sup>Accepted February 26, 2005

<sup>2</sup>Foundation for Ecological Security, 18-New Ahinsapuri, Fatehpura, Udaipur 313 001, Rajasthan, India.  
Email: sksharma@gmail.com

The Indian Garden Lizard *Calotes versicolor* is one of the commonest arboreal lizards in Rajasthan. It can be seen everywhere, scaling rough-barked trees, especially *Acacia nilotica* and *Prosopis cineraria*. During the non-breeding season, males are brown or sand grey above, uniform or with a pattern of spots and bars on the back and the sides (Daniel 2002), but as the breeding season commences (late summer to early monsoon), males acquire a brilliant crimson or scarlet colour on the forehead and the shoulders. Black patches also appear upon the neck, the cheeks and on the throat (Smith 1935; Tikader and Sharma 1992; Daniel 2002; Sharma 1998, 2001).

Two colour morphs have been recognized in the male *C. versicolor* in Rajasthan (Sharma 2001). Individuals,

confined to the southern end of Rajasthan (Udaipur) differ in colour pattern from those in the northern part (Jaipur). The major difference is seen in the extent of its black patch. The black patch in the southern form is confined to the neck region, just touching the swollen cheeks and far from the tympanum, while in the northern form the broader black patch extends up to the swollen cheeks and passes below the tympanum. Both morphs have blackish lower eyelids, but the black is more prominent in the southern morph.

During a recent survey, a third colour morph was found in north-east Rajasthan (Alwar). During the breeding season, the males of this area attain a scarlet colour on the head, gular pouch and dorsal side. Black colour appears on the trunk and forelimb, extends towards the anterior half of its belly and



disappears just near the lumbar zone. No black patch is present on the lower eyelid. Alternate whitish and blackish bands are present on the dorsal side of the distal end of the tail. This colour form seems larger than the other two colour forms.

It is a well-established fact that, just after mating, males lose their scarlet coloration quickly, but the black patches remain (Sharma 1998). From May 7, 2002 to June 14, 2002, while studying the colour pattern of the male *C. versicolor* on the Alwar-Behror Road in Alwar district, many trampled specimens were observed and it was found that males lose

their breeding colours after death. Although a light tinge of scarlet colour can be seen after death, no black colour is visible.

Photographic evidence for the morphs has been provided.

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### 15. RECORD OF *BOIGA BEDDOMEI* (WALL 1909) FROM SRIHARIKOTA, ANDHRA PRADESH, INDIA<sup>1</sup>

S. SIVAKUMAR<sup>2,3</sup> AND RANJIT MANAKADAN<sup>2,4</sup>

<sup>1</sup>Accepted December 15, 2004

<sup>2</sup>Bombay Natural History Society, Hornbill House, S.B. Singh Road, Mumbai 400 023, Maharashtra, India.

<sup>3</sup>Email: sivaprema3sep@yahoo.com

<sup>4</sup>Email: ransan5@rediffmail.com

On March 30, 2004, while carrying out herpetofaunal sampling in Sriharikota, Andhra Pradesh, we recorded a greenish cat snake in a Casuarina plantation. The plantation, raised as a shelter belt, was c. 300 m from the Bay of Bengal. The average tree height was 19 m, with about 90% canopy and 100% litter cover. The snake was recorded under a huge pile of palm leaves accumulated under a *Borassus flabellifer* tree with a fallen Casuarina tree heaped with dense accumulated litter and a 3.5 m shrub to the side of the pile.

Sriharikota is a spindle shaped island (c. 181 sq. km), situated largely in the Nellore district of Andhra Pradesh (with a portion of its southern part in Tiruvallur district of Tamil Nadu), bounded on the east by the Bay of Bengal and on the west, north and south by the Pulicat lake (461 sq. km). The island is acknowledged to have one of the last, largest, and best-preserved patches of Tropical Dry Evergreen Forest in India (Sastry and Rao 1973; Blasco and Legris 1973; Meher-Homji 1974). Beside its natural forest, the island has plantations of Eucalyptus, Casuarina and Cashew, covering 21% of the landmass. The island has been under the control of the Indian Space Research Organisation (ISRO) since the

early 1970s, while the forest and its wildlife are protected. The nearest major forest to Sriharikota is the Eastern Ghats, running about 100 km to the west.

The snake was 88 cm in total length with a snout-vent length of 68.6 cm. The dorsal region was dull green with distinct black horizontal bars. The throat was white with a yellow border, and the entire ventral region was deep yellow. A dark streak ran from the back of the eye to the neck. The eyes were large, with a greenish-brown iris and a black, vertical pupil. It had 8 supralabials with the 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> touching the eye; body scale row of 19:19:13; ventrals 248, and 106 subcaudals. (Some of the body measurements are: eye = 3.22 mm; distance between eye & nostril = 3.22 mm; distance between nostril and snout = 1.88 mm; head length = 18.27 mm and head width = 12.7 mm). Voucher specimen was deposited in the BNHS Collection (Regn. No. BNHS 3343).

The snake was identified as *Boiga beddomei* (Wall 1909), supposedly endemic to the Western Ghats and Sri Lanka (Smith 1943). The species was not listed in the faunal list of the eastern region of India, which includes *B. forsteni* (Dumeril,

Bibron & Dumeril 1854), *B. multifasciata* (Blyth 1861), *B. nuchalis* (Gunther 1875), *B. ochraceus* (Gunther 1868) and *B. trigonatus* (Schneider 1802) (Molur and Walker 1998). Our record of the *Boiga beddomei* in the insular, coastal forest of Sriharikota, 100 km east of the Eastern Ghats that is contiguous with the Western Ghats, suggests that the species may possibly also occur in the Eastern Ghats.

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# 16. *MICRIXALUS FUSCUS* (ANURA: MICRIXALIDAE) IN SHARAVATHI RIVER BASIN, KARNATAKA<sup>1</sup>

K.V. GURURAJA<sup>2,3</sup>, SAMEER ALI<sup>2,4</sup> AND T.V. RAMACHANDRA<sup>2,5</sup>

<sup>1</sup>Accepted June 12, 2004

<sup>2</sup>Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012, Karnataka, India

<sup>3</sup>Email: gururaj@ces.iisc.ernet.in

<sup>4</sup>Email: sameer@ces.iisc.ernet.in

<sup>5</sup>Email: cestvr@ces.iisc.ernet.in

*Micrixalus fuscus* (Boulenger 1882) is endemic to the Western Ghats (Chanda 2002). Inger *et al.* (1984) recorded this species from the Ponmudi hill range in Kerala (9° 55' N, 77° 05' E), whereas Vasudevan *et al.* (2001) observed them in the Kalakkad-Mundanthurai Tiger Reserve, Tamil Nadu (8° 25' - 8° 53' N, 77° 10' - 77° 35' E).

Eight individuals of *M. fuscus* were recorded from Niluvase (13° 44' 18" N, 75° 06' 30" E; 692 m above msl) during the ecological status assessment studies at the Sharavathi River Basin on November 6, 2003. This species was found in the small rocky crevices in the flowing perennial streamlet covered with leaf litter in evergreen forest (water depth: 78.33 ± 10.41 mm; water temperature: 22° C; air temperature: 23° C). They were observed to jump quickly from one rocky surface to another on disturbance, and to hide in the crevices. The vegetation included *Mastixia arborea*, *Ventilago madraspatana*, *Aglaiia* sp. and *Agrostistachys indica*. A specimen was deposited at the National Zoological Collections of Zoological Survey of India, Kolkata (Regn. No. A9865).

*Micrixalus fuscus* is a small, brown torrent frog (snout vent length: 19.34 ± 2.3 mm). Its finger and toe tips are dilated into small discs. The webbing is more than ¾ in its foot. The

distinct features of this species are tibio-tarsal articulation reaching between eye and snout, indistinct tympanum and strongly overlapping hind limbs (when folded at right angles to the body).

The entire dorsum is dark reddish brown. A blackish inverted 'V' on the mid-dorsum and also between the eyes was observed in two specimens. Dorsolateral fold is with dark brown or with white dots. The lateral band is black and extends up to the groin. Limbs are cross-barred. Brown reticulation was noticed on the ventral side up to the abdomen and a light white strip from the anus to the knee joint.

Other species found in the region during the field survey were *Nyctibatrachus major*, *Indirana semipalmatus*, *Euphlyctis cyanophlyctis*, *Sphaerotheca rufescens*, *Philautus* sp. and *Sylvirana* sp.

This record of *M. fuscus* from the Sharavathi River Basin is the first record from Karnataka with an extended range of 13-14° N in the Western Ghats, as there was no previous record from Karnataka.

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# 17. OCCURRENCE OF *MELANOBATRACHUS INDICUS* BEDDOME 1878 IN MATHIKETTAN SHOLA, WESTERN GHATS<sup>1</sup>

A.M.A. NIXON<sup>2,3</sup> AND S. BHUPATHY<sup>2,4</sup>

<sup>1</sup>Accepted September 10, 2004

<sup>2</sup>Sálim Ali Centre for Ornithology and Natural History, Anaikatti (PO), Coimbatore 641 109, Tamil Nadu, India.

<sup>3</sup>Email: nixonarmstrong@gmail.com

<sup>4</sup>Email: sb62in@yahoo.co.uk, salimali@vsnl.com

The Malabar Black Narrow-mouthed Frog *Melanobatrachus indicus* Beddome 1878 (Anura: Microhylidae) is endemic to the southern Western Ghats of India (Dutta 1997). Distribution of this species is poorly known due to lack of intensive surveys. No firsthand information was available since its description by Boulenger (1890). Recently, it has been reported from the Kalakkad – Mundanthurai Tiger Reserve (Vasudevan 1997), Periyar Tiger Reserve (Daltry and Martin 1997) and from Valparai (Ishwar 2000).

The Sálim Ali Centre for Ornithology and Natural History (SACON), in association with the Kerala Forest Department, is conducting studies on the reptiles of Mathikettan shola. This shola is a part of the western slope of Western Ghats, and is located in the Idukki district of Kerala (Fig. 1). Altitude of the area is 1,400-1,800 m above msl, and it receives over 2,500 mm of rainfall annually. Mathikettan shola has recently been proposed as a national park, which includes about 6,500 ha of tropical evergreen forest and 700 ha of abandoned cardamom plantations.

Two specimens of *Melanobatrachus indicus* were observed on January 17, 2004 in the Santhampara of Mathikettan shola. Photographs are deposited with SACON. External appearance and coloration of these frogs were similar to that described by Boulenger (1890): body slender, head without cranial ridge, circular pupil, skin pustular above and smooth below, and black dorsal surface with a scarlet patch near the groin and between forelegs. One of the specimens (live) measured 33 mm in snout-vent length, and it is the largest

specimen reported so far (Daltry and Martin 1997).

During the present study, both frogs were found under decaying wood. The surroundings had thick leaf litter and canopy cover (> 80%), and a perennial stream was found about 200 m away. All the reported *M. indicus* so far have

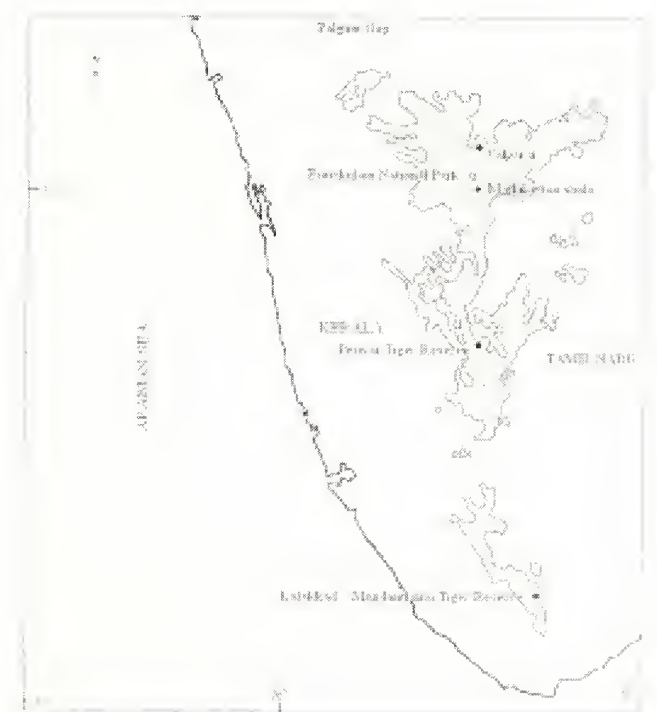


Fig. 1: Map of the southern Western Ghats showing Mathikettan shola and the adjoining hills



been sighted within five metres of perennial streams (Daltry and Martin 1997; Ishwar 2000). The present observation reveals that this species may also occur a considerable distance away from water. The altitude of this locality was 1,450 m msl, and all previous sightings of *M. indicus* were within 1,000-1,500 m. This indicates the restricted distribution of this species with respect to altitude. Though the present record lies within the distributional range of this species, lack of precise locality data makes the present observation noteworthy. This is also one of the four reliable records

available for this species since its description (Daltry and Martin 1997; Vasudevan 1997; Ishwar 2000), which is the second for the Western Ghats of Kerala.

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### 18. NEW RECORD OF THE SIMPLE ASCIDIAN *STYELA PLICATA* (LESUEUR 1823)<sup>1</sup>

V.K. MEENAKSHI<sup>2</sup> AND S. SENTHAMARAI<sup>3</sup>

<sup>1</sup>Accepted, December 29, 2004

<sup>2</sup>Department of Zoology, A.P.C. Mahalaxmi College for Women, Tuticorin 628 002, Tamil Nadu, India. Email: vkmeenakshi@yahoo.com

<sup>3</sup>Ameen Teacher Training Institute, Puthur, Somasipadi, Thiruvannamalai 606611, Tamil Nadu, India.

A simple ascidian — *Styela plicata* (Lesueur 1823) is reported for the first time from Tuticorin harbour, Tamil Nadu, India. Only two species of the genus *Styela* have been reported earlier from India (Renganathan 1981; Krishnan *et al.* 1989); both the species reported, *Styela bicolor* and *Styela canopus*, occur as fouling organisms in Tuticorin and Bombay harbour.

#### *Styela plicata* (Lesueur 1823)

**Occurrence and distribution:** Numerous specimens were collected from the sheltered waters of Tuticorin harbour (8° 48' N, 78° 11' E), seen attached to piers, pilings, other harbour installations, corals and also from the pearl oyster cages suspended at a depth of 4-5 m. This species has been previously reported from Australia (Hartmeyer and Michaelsen 1928; Kott 1952, 1972 a, b, c, 1975), Hong Kong (Tokioka and Nishikawa 1975; Kott and Goodbody 1982), western Indian Ocean (Michaelsen 1918), Japan (Tokioka 1960), West Indies (Van Name 1921, 1930, 1945), Atlantic Ocean and Mediterranean Sea (Harant 1927a, b; Harant and Vernieres 1933; Heller 1877) and eastern coast of North America (Van Name 1912; Huntsman 1912, 1913).

**Synonymy:** *Ascidia plicata* Lesueur 1823, p. 5, *Ascidia*

*plicata*: DeKay 1843, p. 259, *Styela gyrosa*: Heller 1877, p. 255, *Styela gyrosa*: Herdman 1882, p. 155, *Styela plicata*: Traustedt 1883a, p. 123, *Styela plicata*: Traustedt 1883b, p. 478, *Styela plicata*: Traustedt 1885, p. 44, *Styela pinguis*: Herdman 1899, p.40, *Tethyum plicatum*: Hartmeyer 1909, p. 1359, *Tethyum plicatum*: Van Name, 1912, p. 569, *Styela plicata*: Huntsman 1912, p. 149, *Styela plicata*: Huntsman

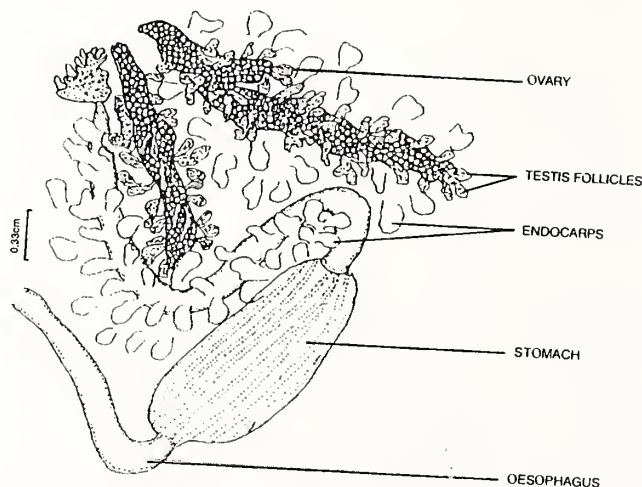


Fig. 1: *Styela plicata*: gut loop and gonads

1913, p. 489, *Styela plicata*: Redikorzev 1916, p. 197, *Styela plicata*: Michaelsen 1918, p. 36, *Styela plicata*: Van Name 1921, p. 435, *Styela plicata*: Harant 1927a, p. 243, *Styela plicata*: Harant 1927b, p. 7, *Styela plicata*: Van Name 1930, p. 492, *Styela plicata*: Harant and Vernieres 1933, p. 31, *Styela plicata*: Van Name 1945, p. 295, *Styela plicata*: Kott 1952, p. 216, *Styela plicata*: Tokioka 1960, p. 213, *Styela plicata*: Millar 1966, p. 370, *Styela plicata*: Kott 1972a, p. 185, *Styela plicata*: Kott 1972b, p. 239, *Styela plicata*: Kott 1972c, p. 254, *Styela plicata*: Kott 1975, p. 13, *Styela plicata*: Tokioka and Nishikawa 1975, p. 338, *Styela plicata*: Kott 1985, p. 116.

**Taxonomy:** Class: Ascidiacea, Order: Pleurogona, Suborder: Stolidobranchia, Family: Styelidae, Subfamily: Styelinae.

**Description:** Individuals upright, cylindrical, fixed by the posterior end of their body. Size of the specimen 1-4 cm. Animals sessile, without any roots or stalks. Test firm, slightly translucent, yellowish orange with epibionts like *Didemnum psammathodes* and *Distaplia nathensis* attached to the surface. Surface of the test with many faint longitudinal and circular creases. Branchial aperture terminal, atrial aperture antero-dorsal. Apertures on very short conical siphons heavily pigmented. Siphon lining with prominent flattened spines.

**Internal structure:** The body wall is thick and has well developed circular muscles crossed by longitudinal muscles radiating from the siphons. Dorsal tubercle has a U-shaped slit directed anteriorly with both horns turned in. There are 4 wide branchial folds with 18-25 internal longitudinal vessels crowded on the folds and 6-10 between the folds. There are 5-6 long stigmata in each mesh. Gut loop is very narrow and

deeply curved (Fig. 1). Stomach is long and occupies more than half of the ascending limb of the primary loop. It has many fine longitudinal folds arranged parallel to one another on its external surface. Rectum runs parallel to the descending limb of the primary gut loop and extends anteriorly towards the base of the atrial aperture. The anus is deeply lobed. There are two gonads on the left and four on the right, radiating from the atrial aperture. Each gonad has a central tubular, long ovary bordered by branched testis follicles attached to the body wall. Endocarps are crowded, distributed on the body wall along both sides of the intestine, enclosed in the gut loop and on the body wall between the gonads.

## REMARKS

The firm, slightly translucent yellowish orange test, heavily pigmented short conical siphons, deeply curved gut loop, crowded endocarps, long branched testis follicles distributed along the length of the ovary are characteristic to the species. This species is being reported for the first time in Indian waters. The specimen studied has been deposited in the Museum of A.P.C. Mahalaxmi College for Women (Regn. No. APCMAS 2002).

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## 19. SPIRALLING WHITEFLY *ALEURODICUS DISPERSUS* RUSSELL (HOMOPTERA: ALEYRODIDAE) INVADES ANDAMANS<sup>1</sup>

G. SHYAM PRASAD<sup>2,3</sup>, S. BHAGAT<sup>2,4</sup> AND V. JAYAKUMAR<sup>2,5</sup>

<sup>1</sup>Accepted April 23, 2007

<sup>2</sup>Central Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands 744 101, India.

<sup>3</sup>Current Address: National Research Centre for Sorghum, Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India. Email: shyamprasad@nrcsorghum.res.in

<sup>4</sup>Email: sombhagat73@rediffmail.com

<sup>5</sup>Email: jkpath@rediffmail.com

Whiteflies, including the Spiralling Whitefly *Aleurodicus dispersus* Russell (Homiptera: Aleyrodidae), pose a severe threat to many agricultural and horticultural crops, both in glass house and field conditions, due to their wide host range. This pest is native to the Caribbean Islands and Central America. The Spiralling Whitefly is now reported to occur in North America, South America, Asia, Africa, Australia and several Pacific Islands.

In India, it was first reported in 1993, in the Western Ghats, Kerala, Kanyakumari district, Tamil Nadu (Palaniswami *et al.* 1995). It later spread to parts of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra (David and Regu 1995; Palaniswami *et al.* 1995; Ranjith *et al.* 1996; Mani and Krishnamoorthy 1996; Mani *et al.* 2000, 2001). The Spiralling Whitefly is believed to have been introduced into India from the Maldives and Sri Lanka (Ranjith *et al.* 1996) through plant material.

The pest can be easily recognized by the characteristic spiral arrangement of eggs on the lower lamina of leaves, which can be seen as a white patch. The nymphs and adults of Spiralling Whitefly suck the sap from the surface of leaves,

stem and fruits. The copious white, waxy, flocculent material secreted by the nymphs, readily spreads to adjacent vegetation by wind. This sticky honeydew favours the growth

**Table 1:** Host range of *A. dispersus* in the South Andamans

Common name	Scientific name	Family
Guava	<i>Psidium gujava</i> Linn.	Myrtaceae
Banana	<i>Musa</i> sp. Linn.	Musaceae
Papaya	<i>Carica papaya</i> Linn.	Caricaceae
Red Gram	<i>Cajanas indicus</i> Spreng.	Leguminosae
Curry Leaf	<i>Murraya koenigii</i> Sl.	Rutaceae
Cassava	<i>Manihot esculenta</i> Crantz	Euphorbiaceae
Brinjal	<i>Solanum melongena</i> L.	Solanaceae
Tomato	<i>Lycopersicon esculentum</i> Mill	Solanaceae
Chilly	<i>Capsicum annum</i> L.	Solanaceae
Lady's Finger	<i>Abelmoschus esculentus</i> (L.) Moench	Malvaceae
Canna	<i>Canna indica</i> L.	Cannaceae
Tulsi	<i>Ocimum sanctum</i> L.	Labiatae
Ageratum	<i>Ageratum conyzoides</i> L.	Compositae
Gerbera	<i>Gerbera jamesonii</i> H. Bolus ex J.D. Hook	Compositae



of the sooty mould fungus, *Capnodium ramosum* Cooke, which imparts a blackish colour to leaves, and reduces the photosynthetic area.

The Spiralling Whitefly is highly polyphagous and thrives on 481 host plants belonging to 295 genera and 90 families (Srinivas 2000). Though the Andaman Islands are completely cut off and remote from the Indian mainland, they are well connected by both air and sea. In the South Andamans, during July 2003, severe infestation of this pest was recorded for the first time on guava.

A preliminary survey conducted between July 2003–November 2003 indicated that *A. dispersus* attacks the following crops in South Andamans (Table 1). This pest is

multiplying rapidly due to conducive climatic conditions prevailing in the South Andamans. The possible route of entry of this pest into the South Andamans is through mainland India with planting material imported by various agencies, as in case of the Citrus Blackfly *Aleurocaulth woglumi* Ashby. The Citrus Blackfly was introduced into the Andamans in 1990 along with 2000 budlings of Mandarin oranges brought by the State Agriculture Department from South Arcot, Tamil Nadu for distribution to farmers (Bhumannavar *et al.* 1991). Stringent quarantine measures at the ports (points of entry) on the Indian mainland, as well as these Islands, can prevent such unintended introduction, which could become a menace.

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## 20. OCCURRENCE OF *LUMBRINERIS HARTMANI* (DAY 1953) (POLYCHAETA: LUMBRINERIDAE): A NEW RECORD FOR INDIAN WATERS<sup>1</sup>

R. RAJASEKARAN<sup>2,3</sup> AND OLIVIA J. FERNANDO<sup>2,4</sup>

<sup>1</sup>Accepted July 10, 2004

<sup>2</sup>CAS in Marine Biology, Annamalai University, Parangipettai 608 502, Tamil Nadu, India.

<sup>3</sup>Email: sekar\_10677@yahoo.co.in

<sup>4</sup>Email: cdl\_aucasmb@sancharnet.in, olivia\_cas@yahoo.com

Members of the Lumbrineridae, a family of the Order Eunicomorpha, are very homogeneous in their general external morphology. All of them have a simple prostomium; a long body not clearly portioned into regions and subbiramous parapodia without ventral cirri. They commonly burrow in sandy mud and have lost their head appendages. On the other hand, the anterior end of the prostomium is richly supplied with nerves while the jaws are very powerful. A few species of *Lumbrineris* are found under stones and in algal tufts.

In earlier studies the occurrence of *Lumbrineris tetraura*, *L. notocirrata*, *L. polydesma*, *L. heteropoda*, *L. simplex*, *L. impatiens*, *L. bilabiata*, *L. latreilli* and *L. pseudobifilaris* has been recorded from diversified environments along the east and west coast of India (Fauvel 1953; Parulekar 1971; Hartman 1974; Antony and Kuttyamma

1983; Rao 1998; Misra *et al.* 1984; Srikrishnadhas *et al.* 1987; Misra 1995; Sunder Raj and Sanjeeva Raj 1987; Pillai 2001).

During the present study three specimens of *Lumbrineris hartmani* were collected from the sand beneath seagrass beds in the intertidal area of Krusadai Island (9° 14' N, 79° 12' E) in the Gulf of Mannar on August 12, 2001. This island has well-developed coral reefs and extensive seagrass beds. The sediment samples collected were sieved through a 0.5 mm sieve, and the animals retained were stored in 70% alcohol for further studies. All drawings were made using Camera Lucida.

All three specimens collected were incomplete, with a maximum length of 70 mm for 203 segments. Prostomium is depressed, conical (Fig. 1a); eyes and nuchal organ are absent. Peristomium is composed of two apodous segments; it is as

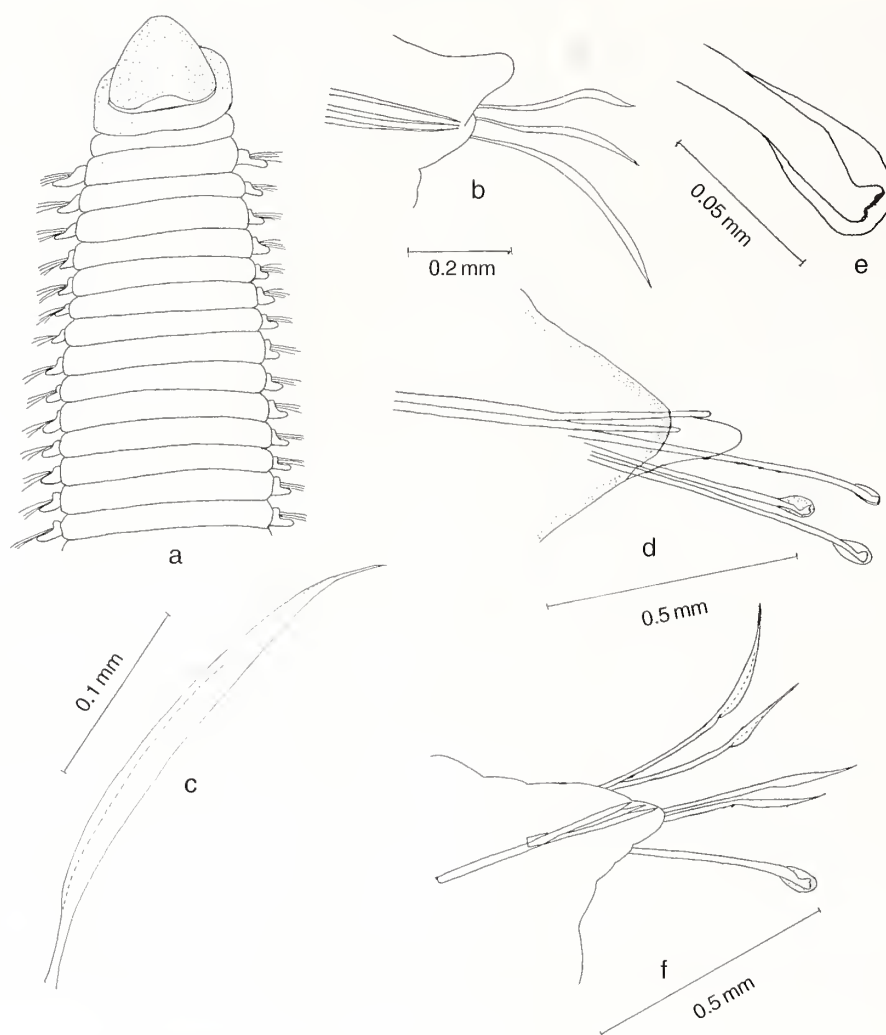


Fig 1. a-f: a. Anterior end, b. Anterior parapodia, c. Winged capillary, d. Posterior parapodia, e. Bidentate hooded hook, f. Middle parapodia

long as the first setigerous segment. Maxillary supports long and triangular. Maxillae I (forceps) is falcate; maxillae II has five teeth; maxillae III two teeth and maxillae IV one tooth. Some anterior parapodia are reduced. Anterior parapodia (Fig. 1b) with winged capillary setae (Fig. 1c), posterior (Fig. 1d) with bidentate hooded hooks (Fig. 1e), a few middle segments (Fig. 1f) with capillary setae and bidentate hooded hooks. Dorsal and ventral cirri are absent.

Setae and simple bidentate hooded hooks are present from 19<sup>th</sup> parapodial segment and continue to the end of body, blade is shorter after the middle of the body. Three acicula in each parapodium. Parapodia with unequal lobes, the anterior

feet, having a low, rounded presetal lobe and a longer, conical, postsetal one. In posterior feet the postsetal lobe is longer but never exceeds the length of the setae.

This specimen has been deposited in the Marine Biology Museum, Parangipettai (Regn. No.: MBM-AN-005).

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## 21. MORPHOLOGY AND IDENTIFICATION OF CLADOCERAN FAUNA OCCURRING IN THE FISH SEED FARM, AAREY, MUMBAI, INDIA<sup>1</sup>

S.D. PATIL<sup>2,3</sup> AND U.A. SIDDHAM<sup>2</sup>

<sup>1</sup>Accepted December 07, 2004

<sup>2</sup>Taraporevala Marine Biological Research Station, Dr. B.S. Konkan Agricultural University, New Administrative Building,

3<sup>rd</sup> Floor, Government Colony, Bandra (East), Mumbai 400 051, Maharashtra, India.

<sup>3</sup>Email: tmbrs@rediffmail.com

### Introduction

Aquaculture has to play an important role in providing rich proteinaceous food, needed constantly for the ever-increasing human population all over the world. Thus, for intensive production of protein-rich fishes and prawns, it is necessary to provide required zooplanktonic food organisms at an optimum density. Therefore, adoption of basic techniques has been an important consideration by which abundant and sustained production of forageable zooplanktonic food organisms can be produced in high density in a short period of time. The secondary productivity implying production of zooplankton in the water bodies has been always a slow process under natural conditions, and depends upon the pace of primary productivity. However, this natural process may not be obviously suitable for fish and prawn production under fish farm conditions, where quick returns from culture are the essential requirements for commercial viability. Among mass cultured zooplankton in fish nurseries, initial occurrence of Rotifers is essential to provide minute zooplankton to the fish spawn, which has just started feeding. As the spawn grow, they become capable of ingesting slightly larger zooplankton such as Cladocerans and Copepods. Cladocerans are fleshy in nature, highly nutritious and easy to digest; this plays an important role in fish seed production. Shirgur and Indulkar (1987) have emphasized the importance of Cladocerans, which play a significant role as forage organisms for the growing carp fry. It is, therefore, clear that there is a great scope to survey and study the Cladoceran fauna of fish farms so as to understand the species-wise profile among the zooplanktons in fish farm conditions and to assess them on the basis of their mass culture response. The present studies were carried out at a Government Fish

Seed Farm, Aarey, Mumbai, on the morphology and identification characters of different Cladoceran species isolated from fortnightly collected zooplankton samples.

Zooplankton samples were collected from the reservoir and fish nursery ponds at the Aarey Fish Seed Farm, Mumbai, for two years at fortnightly intervals, using conical plankton net (120 µm mesh). The collected samples were preserved in isotonic solution (Shirgur 1984). All the samples were examined for qualitative analysis. From the preserved samples, Cladocerans were separated and identified on the basis of standard identification key for Cladocerans (Ward and Wipple 1966). Dr. R.G. Michael of North-Eastern Hill University, Shillong (Meghalaya) confirmed the identification. The distinguishing characters are depicted using Camera Lucida drawings.

From the zooplankton samples collected for two successive years from Government Fish Seed Farm, Aarey, Mumbai, twelve different species of Cladocerans, namely *Ceriodaphnia cornuta* Sars 1886 (Fig. 1), *Moina micrura* (I) Kurz 1874 (Fig. 2), *Moina micrura* (II) (Fig. 3), *Moina dubia* Guerne & Richard 1892 (Fig. 4), *Macrothrix laticornis* Jurine 1820 (Fig. 5), *Kurzia longirostris* Daday 1850 (Fig. 6), *Alona rectangula* Sars 1862 (Fig. 7), *Alona pulchella* King 1853 (Fig. 8), *Chydorus sphaericus* Muller (1785) (Fig. 9), *Bosminopsis deitersi* Richard 1895 (Fig. 10), *Diaphanosoma excisum* (I) Sars 1885 (Fig. 11) and *Diaphanosoma excisum* (II) Sars var Stingling Jenkin 1934 (Fig. 12) were identified. All these Cladocerans belonged to common taxa (Phylum: Arthropoda; Class: Crustacea; Superorder: Diplostraca; Order: Cladocera; Suborder: Eucladocera), as per the classification adopted from Biswas (1971). Ten species belong to one common Superfamily – Chydoridae and four different



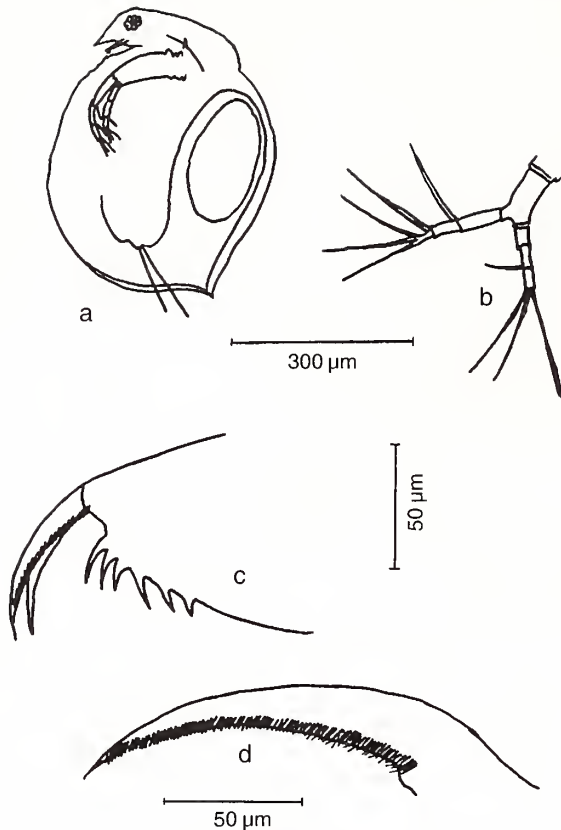


Fig. 1: *Ceriodaphnia cornuta* Sars 1886

a. Parthenogenetic Female, b. Antenna, c. Post abdomen, d. Claw

Families. The remaining two species, *Diaphanosoma excisum* (I) and *D. excisum* (II), belong to the Superfamily Sidoidae and Family – Sididae.

Morphology and distinguishing features of the twelve Cladoceran species are given as below:

1. *Ceriodaphnia cornuta* Sars 1886 (Fig. 1)

Size range: 300-450 mm; fornix with thorn at mid region, above antenna; smooth bristles present at coxal region of antenna (Hoff 1943; Green 1962; Frey 1967).

2. *Moina micrura* Kurz 1874 (I) (Fig. 2)

Size range: 500-600 mm; post-abdominal spines less than eight; supraocular depression absent; pecten on the post-abdomen claw very weak; males with long antennules (Hoff 1943; Ward and Wipple 1966; Michael 1973).

3. *Moina micrura* (II) (Fig. 3)

Size range: 700-850 mm; large variety as compared to *Moina micrura* (I); slight supraocular depression present.

4. *Moina dubia* Guerne & Richard 1892 (Fig. 4)

Size range: 700-900 mm; only stout spines present on proximal region, 6-7 small spines occur separated by solitary stout spines at regular intervals on distal region of stout ventral margin of carapace (Rey and Jean 1968; Biswas 1971).

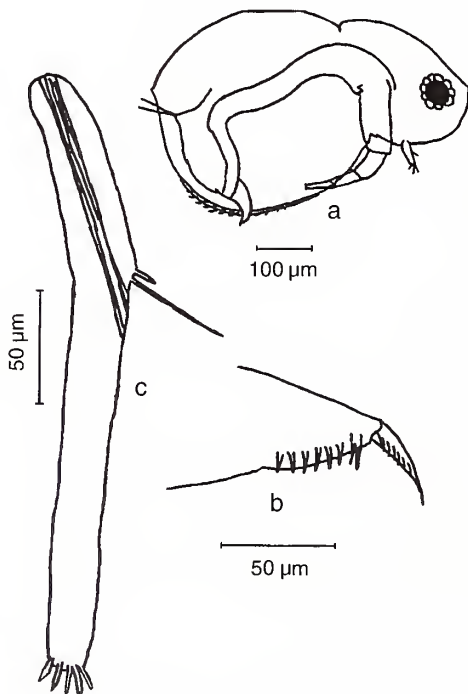


Fig. 2: *Moina micrura* Kurz 1874 (I)

a. Parthenogenetic Female, b. Post abdomen, c. Male antennule

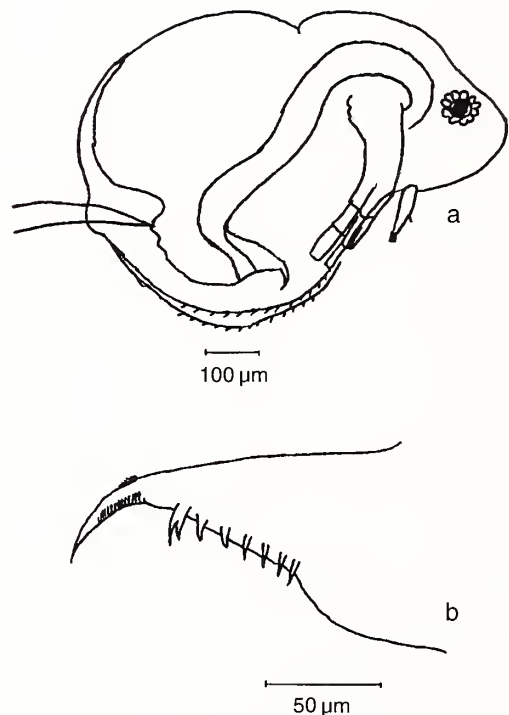


Fig. 3: *Moina micrura* (II)

a. Parthenogenetic Female, b. Post abdomen

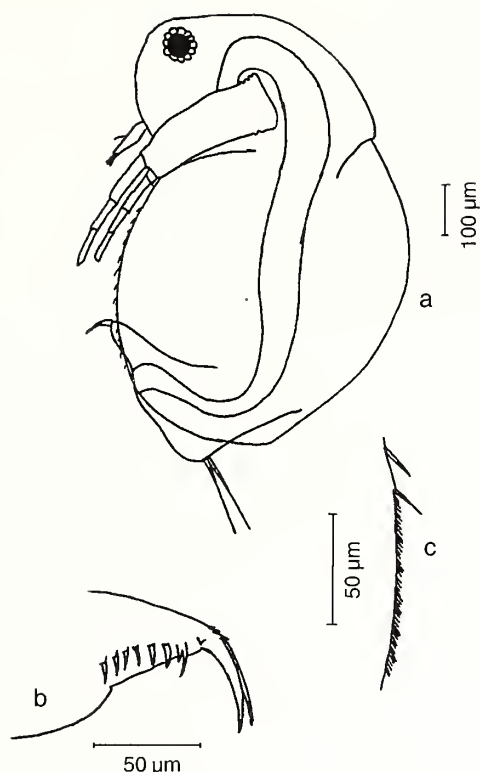


Fig. 4: *Moina dubia* Guerne & Richard 1892  
a. Parthenogenetic Female, b. Post abdomen,  
c. Posteroventral margin of valve

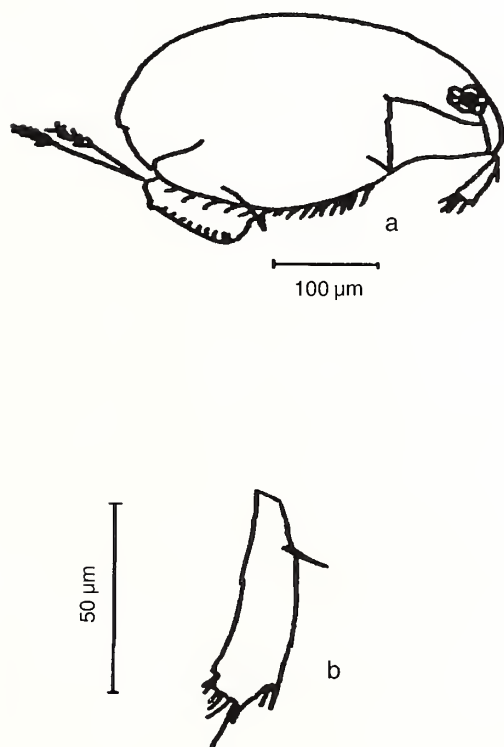


Fig. 5: *Macrothrix laticornis* Jurine 1820  
a. Parthenogenetic Female, b. Antennule

5. *Macrothrix laticornis* Jurine 1820 (Fig. 5)

Size range: 500-700 µm; post-abdomen not bilobed; head evenly rounded; labrum with large triangular process (Ward and Wipple 1966).

6. *Kurzia longirostris* Daday 1898 (Fig. 6)

Size range: 600-700 µm; post-abdomen long with 14 strong marginal spines; length of antennules up to mid-distance of rostrum, sensory bristles at the tip just reach the tip of rostrum (Green 1962; Rey and Jean 1968).

7. *Alona rectangularis* Sars 1862 (Fig. 7)

Size range: 350-450 µm; body ventrally arched, valves striated, reticulated or ventral margin slightly convex; post-abdomen short, slightly elongated towards apex, angle rounded with 8 to 9 marginal denticles or bundles of setae and about as many fascicles, distal ones long enough to project beyond the margin of post-abdomen (Ward and Wipple 1966; Biswas 1971).

8. *Alona pulchella* King 1853 (Fig. 8)

Size range: 350-450 µm; body oval shaped; reticulation absent on valves; antennules with eight sensory bristles at apex; post-anal margin merges smoothly with anal concavity (Rey and Jean 1968).

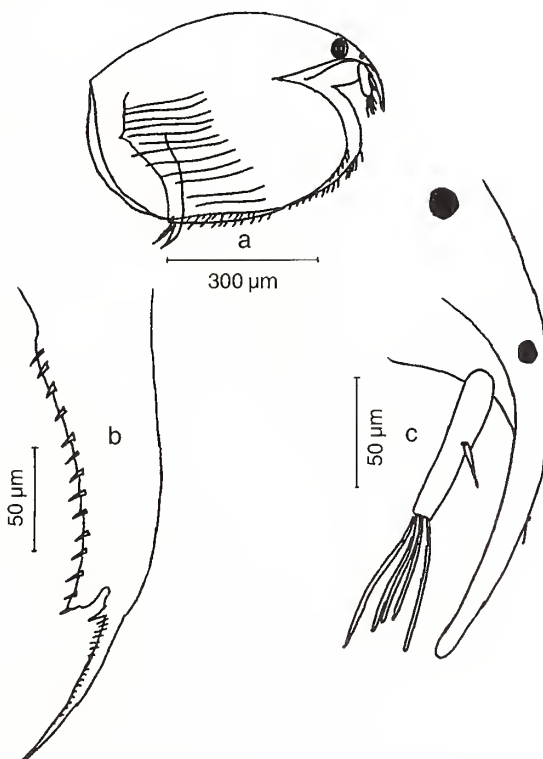


Fig. 6: *Kurzia longirostris* Daday 1898  
a. Parthenogenetic Female, b. Post abdomen,  
c. Lateral view of head

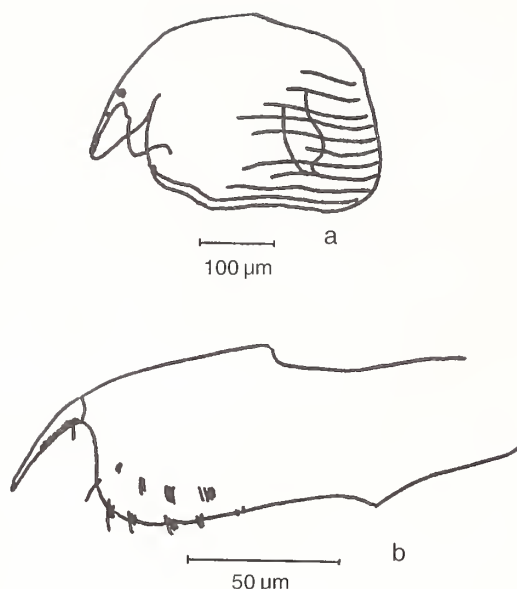


Fig. 7: *Alona rectangularis* Sars 1862  
a. Parthenogenetic Female, b. Post abdomen

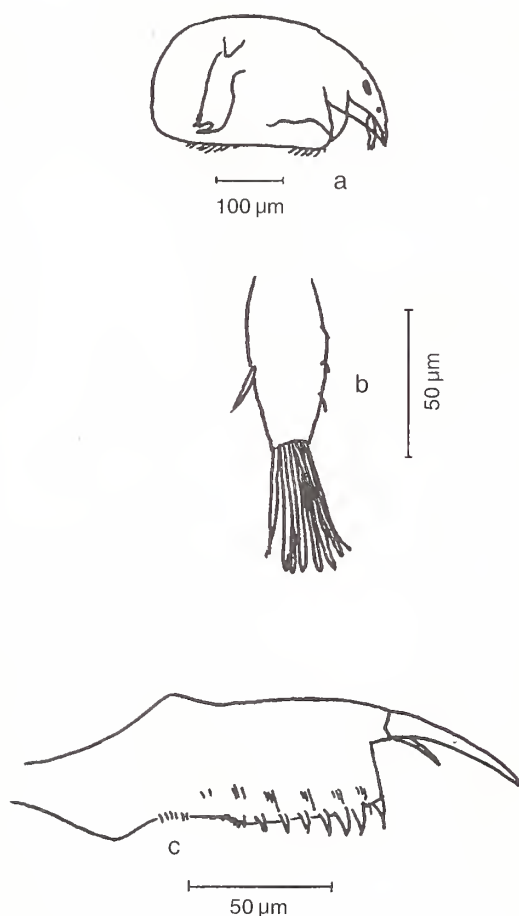


Fig. 8: *Alona pulchella* King 1853  
a. Parthenogenetic Female, b. Antennule, c. Post abdomen

#### 9. *Chydorus sphaericus* Muller 1785 (Fig. 9)

Size range: 300-500 µm; body completely enclosed by shell and head shield; head shield projects over base of antennules as rostrum and laterally over bases of antennae as fornices; antennules not extending beyond tip of rostrum; all olfactory setae at end of antennules; antennular rami three-jointed with setae formula 0-3 / 0-1-3; post-abdomen with 8-9 teeth or denticles along margin, claw small, proximal basal spine very minute (Ward and Wipple 1966; Rey and Jean 1968).

#### 10. *Bosmitopsis deitersi* Richard 1895 (Fig. 10)

Size range: 300-370 µm; antennules united at base, diverging at apex, numerous long straggling olfactory setae on ventral side; post-abdomen tapering to point of claws, one large spine near claw and several minute spinules anterior to it; four small and one large (last) denticles at ventro-posterior margin of carapace (Ray and Jean 1968).

#### 11. *Diaphanosoma excisum* 1885 (I) (Fig. 11)

Size range: 700-900 µm; 7 to 12 spines at postero-ventral angle of carapace; hairs on side of post-abdomen absent;

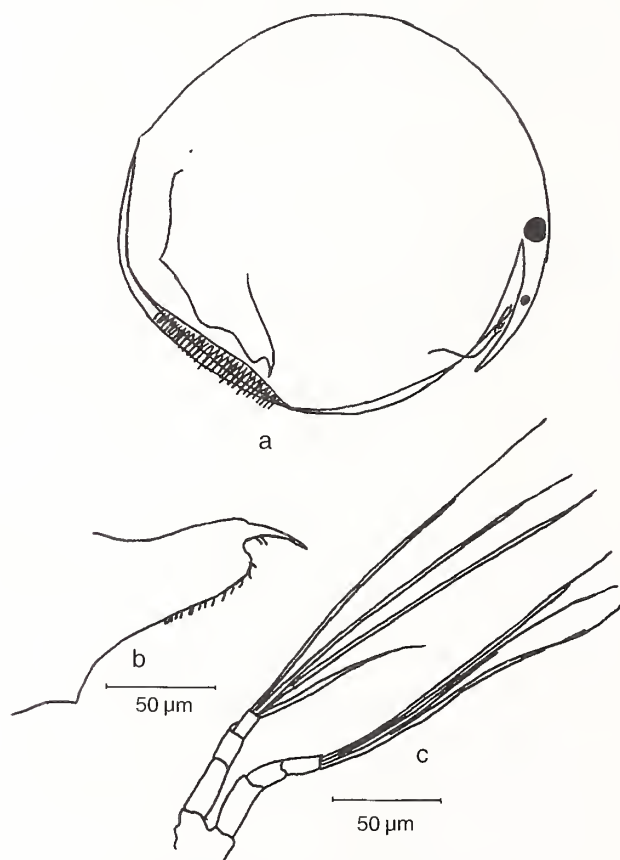


Fig. 9: *Chydorus sphaericus* (O.F. Muller 1785)  
a. Parthenogenetic Female, b. Post abdomen, c. Antenna



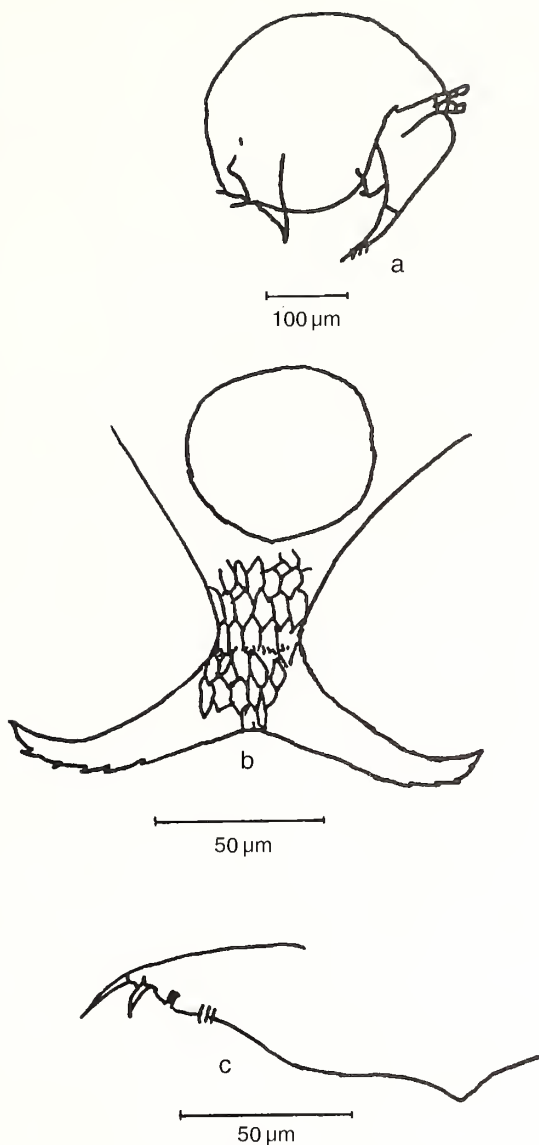


Fig. 10: *Bosminopsis deitersi* Richard 1895  
a. Parthenogenetic Female, b. Dorsal view of antennules,  
c. Postabdomen

antennae short, not more than one third of body length (Biswas 1971).

**12. *Diaphanosoma excisum* (II) Sars  
var. *Stingling* Jenkin 1934 (Fig. 12)**

Size range: 700-900 µm; antenna long, reaching posterior border of shell, the number and pattern of teeth on postero-ventral margin of carapace differ from the above variety (Biswas 1971).

Among the identified Cladocerans, *Moina micrura* Kurz 1874 is mentioned as *M. micrura* (I) which is a smaller variety. The second variety is mentioned as *M. micrura* (II), which is larger in size and also in respect of its constant size and

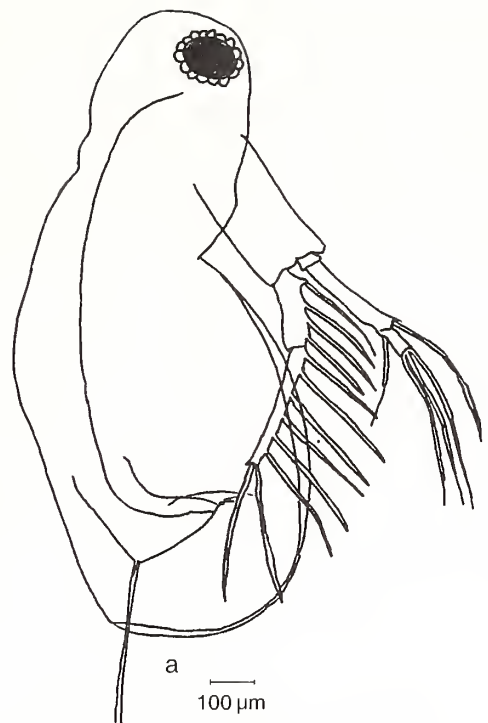


Fig. 11: *Diaphanosoma excisum* Sars 1885 (I)  
a. Parthenogenetic Female

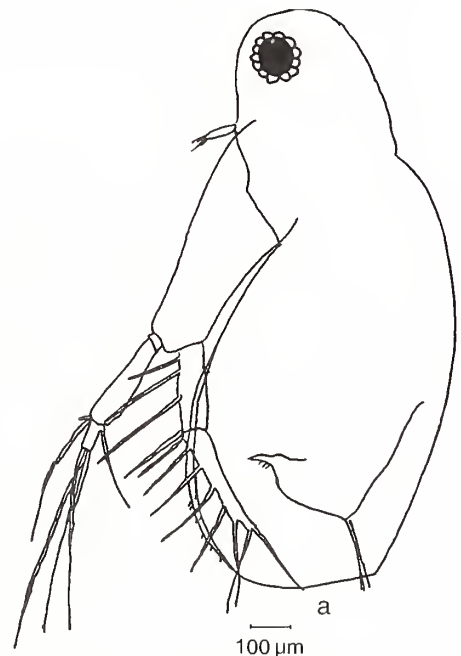


Fig. 12: *Diaphanosoma excisum* (II) Sars  
a. Parthenogenetic Female

morphological identity. Both these varieties occurred in the reservoir and in the selected nursery pond. Regarding *M. micrura* (II), there are no records in relevant literature. Dr. Michael in his identification report has commented: "This is a variable species in size, body shape and it needs to be

worked out for India." *M. micrura* (I) has been extensively recorded in other Indian habitats. In case of the two varieties of *M. micrura*, the supraocular depression is present only in the larger variety. *Diaphanosoma excisum* occurs under two varieties, namely *D. excisum* Sars 1885 (I) and *D. excisum* Sars var. *Stingling Jenkin* 1934 (II). These two varieties can be distinguished on the basis of length of antenna and serration

on the carapace border. Biswas (1971) and Mathew (1977) have reported the Indian occurrence of *D. excisum* Sars 1885 as variety (I). The second variety, *D. excisum* Sars var. *Stingling Jenkin* 1934 (II) was reported by Biswas (1971). All the identified Cladocerans occurred both in the reservoir and in the nursery pond, except *Moina dubia* and *Macrothrix laticornis*, which occurred only in the nursery pond.

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## 22. AEGINETIA INDICA ROXB.: A NEW NON-PHOTOSYNTHETIC ANGIOSPERM FOR JAMMU AND KASHMIR FLORA<sup>1</sup>

HARISH CHANDER DUTT<sup>2,3</sup> AND SHASHI KANT<sup>2,4</sup>

<sup>1</sup>Accepted March 02, 2005

<sup>2</sup>Department of Botany, University of Jammu, Jammu 180006, Jammu & Kashmir, India.

<sup>3</sup>duttharish@rediffmail.com

<sup>4</sup>shashikant@rediffmail.com

During a floristic exploration in the foothills of Jammu in September 2003, the authors collected a specimen of a broomrape with underground parts, growing in a moist and shady habitat, near village Thain of Dayalla Chak, Kathua at an altitude of 600 m above msl. A large population of the species in association with other grasses and *Adiantum* species has been found in this area. The collected specimen has been deposited in the Herbarium, Department of Botany, University of Jammu (Regn. No. SK-HC 1/8248). After a detailed study of the available literature and preserved herbarium collection, the broomrape was identified as *Aeginetia* Roxb. (Fig. 1) of Orobanchaceae – a dicot family.

Perusal of existing literature and collected herbarium sheets implied clearly that this species had not been recorded earlier in Jammu and Kashmir. However, the species has been described by Kehimkar (2000) as a Himalayan species existing between 600-1100 m above msl. A detailed description of this new record to the flora of Jammu and Kashmir is given below:

*Aeginetia indica* Roxb.

*Aeginetia japonica* Siebold & Zuccarini; *Orobanche*

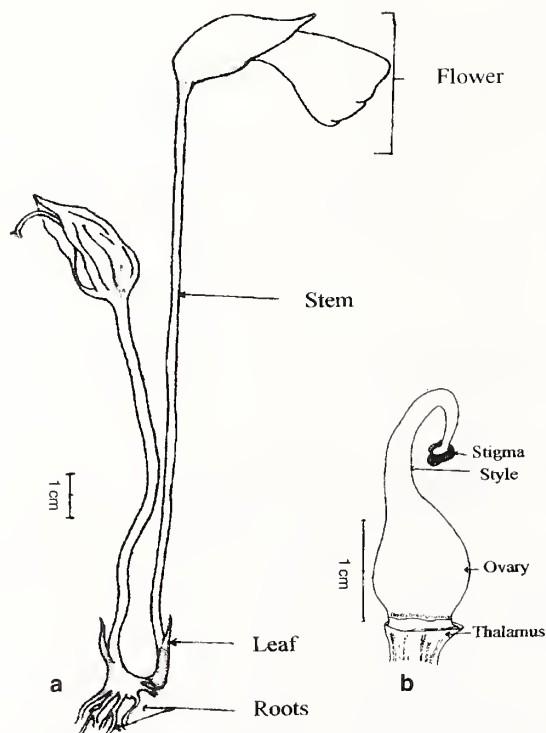


Fig. 1: *Aeginetia indica*: a. Habit; b. Gynoecium

*aeginetia* Linn.; *Phelipaea indica* (Linn.) Sprengel ex Steudel.

Root slightly fleshy. Stems (10-25 cm) branched from near base. Leaves small reddish, ovate, 6-9 x 2-3 mm near the stem base, glabrous. Inflorescence solitary terminal, purplish-red (non-green); flower fimbriate, ebracteate, ebracteolate, 1.25-5 cm long. Calyx acuminate, spathe like, pink. Corolla purplish-red, tubular-campanulate, 1.25-5 cm, long, tube

slightly curved. Ovary 1-locular, parietal placentas four. Style 1-1.5 cm. Capsule conical 1-2 cm. Seeds numerous 0.03-0.04 mm.

**Fl. & Fr.:** May-September.

**Distribution:** Bangladesh, Bhutan, Cambodia, Indonesia, Japan, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, India: western Himalaya in Kumaon to Nepal, Assam and Khasia Hills.

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### 23. *DIOSPYROS NIGRESCENS* (DALZ.) SALDANHA (EBENACEAE): AN ADDITION TO THE FLORA OF TAMIL NADU<sup>1</sup>

S. KARUPPUSAMY<sup>2,3</sup>, K.M. RAJASEKARAN<sup>5</sup> AND T. PULLAIAH<sup>2,4</sup>

<sup>1</sup>Accepted January 11, 2005

<sup>2</sup>Department of Biotechnology, Sri Krishnadevaraya University, Anantapur 515 003, Andhra Pradesh, India.

<sup>3</sup>Email: ksamylin@yahoo.co.in

<sup>4</sup>Email: pullaiaht@yahoo.co.in

<sup>5</sup>Department of Botany, Madura College, Madurai 624 011, Tamil Nadu, India. Email: capt\_kmr@gmail.com

During the floristic survey of the Dindigul district of Tamil Nadu, we came across an interesting species of *Diospyros* in the Sirumalai hills. This species was examined critically, and was identified as *Diospyros nigrescens*. It has not been reported from Tamil Nadu so far. The present study extends its distribution to Tamil Nadu.

*Diospyros nigrescens* (Dalz.) Saldanha in Saldanha & Nicolson, Fl. Hassan. 197. 1976. *Diospyros angustifolia* (Miq.) Kostermans, Ceylon J. Sci. 12: 106. 1977. *Maba nigrescens* Dalz. in Dalz. & Gibson, Bombay Fl. 142. 1861; Cooke, Fl. Bombay 2: 97 (157). 1904; Gamble, Fl. Presi. Madras. 768 (540). 1921.

Trees, branches fulvous-pubescent. Leaf blade elliptic-lanceolate, acute at apex, cuneate at base, with reticulation slightly raised beneath, fulvous hairy on midrib beneath, to 8 x 3 cm. Inflorescence 1-3 flowered, axillary subsessile clusters. Flowers 3-4merous. Calyx lobe ovate, acute, hairy. Corolla white, hairy. Stamens 6-9, pistillode rudimentary, staminodes 0. Ovary 3-celled, hairy. Stigmas 3. Fruit ellipsoid, clothed when young with fulvous silky hairs, fruiting calyx cup shaped (Fig. 1).

**Fl. & Fr.:** February-September.

**Ecology:** Sporadically occur in evergreen forests and stream banks on the Ghats.

**Distribution:** Confined to the Bombay Presidency in Konkan and Kanara (Cooke 1908), the Sirumalai hills of Tamil Nadu.

**Specimen examined:** The Sirumalai hills (Eastern Ghats), Dindigul district, Tamil Nadu. Karuppusamy and Rajasekaran, 1058 (SKU), Karuppusamy, 1131 (SKU).



Fig. 1: *Diospyros nigrescens* (Dalz.) Saldanha:  
A. Flowering twig, B. Flower, C. Fruit

#### REFERENCE

COOKE, T. (1908): Flora of the Presidency of Bombay, Vol. III. Bishen Singh Mahendra Pal Singh, Dehradun. Pp. 157-158.



24. *CONVOLVULUS MICROPHYLLUS* SIEB. EX SPRENG. (CONVOLVULACEAE):  
A NEW RECORD FOR PENINSULAR INDIA<sup>1</sup>

S. KARUPPUSAMY<sup>2,3</sup> AND T. PULLAIAH<sup>2,4</sup>

<sup>1</sup>Accepted January 11, 2005

<sup>2</sup>Department of Biotechnology, Sri Krishnadevaraya University, Anantapur 515 003, Andhra Pradesh, India.

<sup>3</sup>Email: ksamylin@yahoo.co.in

<sup>4</sup>Email: pullaiaht@yahoo.co.in

*Convolvulus* Linn. is a cosmopolitan genus, comprising of about 250 species, mostly found in temperate and subtropical regions of both hemispheres, rare in the tropics. In peninsular India, it is represented by about four species (Biju 1997). During our study on the flora of Dindigul district we collected *Convolvulus microphyllus* Sieb. ex Spreng., which is an addition to the flora of peninsular India.

*Convolvulus microphyllus* Sieb. ex Spreng. Syst. 1: 611, 1825; Wt. Ic. t. 1367, 1848; Heine in Kew Bull. 16: 205, t. 147, 1962; FBI 4: 218, 1883; Cooke 2: 233, 1905 repr. 2: 301, 1958; Blatt. et Hallb. in JBNHS 26: 544, 1919; Fl. Raj. 93, 1964; Ills. Fl. Del. t. 147, 1966; Sharma et Tiagi, Fl. North-east Raj. 261, 1979. *C. plurilocularis* Choisy, Mem. Soc. Phys. Geneve 6: 677, 1833 et in DC. Prodr 9: 403, 1845; FBI 4: 218, 1883; FUGP 2: 105, 1911, repr. 1: 547, 1952; Fl. Del. 239, 1963.

A suffrutescent branched herb, densely hairy. Leaves linear-oblong to elliptic, obtuse, mucronate, lamina tapering towards base, surfaces densely villous. Flowers axillary, solitary or in cymes of 2-4, sessile or shortly pedicellate, bracteate flowers funnel-shaped, white with pinkish tinge. Sepals and stamens unequal. Ovary 2-celled, ovules 4. Style filiform, stigmas 2, linear or oblong, distinct. Fruit a globose capsule, 2-celled, 4-valved. Seeds 4, glabrous, smooth (Fig. 1).

**Fl. & Fr.:** Usually rainy season (August-October).

**Ecology:** A common plant of sandy areas. The flowers open during early morning hours.

**Distribution:** Nambia, and from Egypt to India (Blatter *et al.* 1978), Baluchistan (Burkill 1983), Rajasthan in India (Sharma and Tiagi 1979) and Dindigul district of Tamil Nadu.

**Specimen examined:** Oddanchatram, Dindigul district, Tamil Nadu. S. Karuppusamy, 782 (SKU), Palani, Dindigul district, Tamil Nadu, S. Karuppusamy, 1086 (SKU).

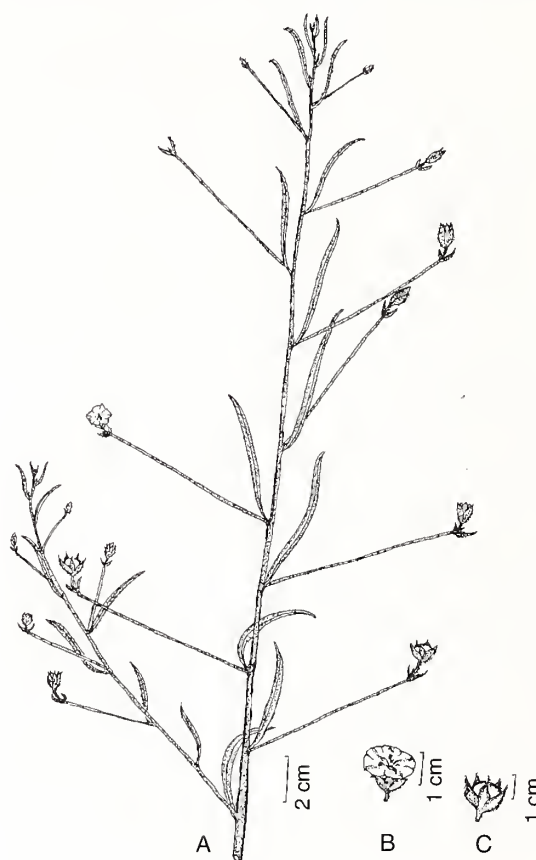


Fig. 1: *Convolvulus microphyllus* Sieb. ex Spreng:  
A. Habit, B. Flower, C. Fruit with calyx

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25. *STEBBINSIA UMBRELLA* (FRANCH.) LIP. (ASTERACEAE): A NEW RECORD FOR INDIAD. MAITY<sup>2</sup> AND G.G. MAITI<sup>3</sup><sup>1</sup>Accepted February 07, 2005<sup>2</sup>Botanical Survey of India, Sikkim Himalayan Circle, Gangtok 737 103, Sikkim, India. Email: debmaity@yahoo.com<sup>3</sup>Department of Botany, University of Kalyani, Kalyani 741 235, Nadia, West Bengal, India. Email: gaurmaity@yahoo.co.in

*Crepis umbrella* Franch. had been assigned under different genera by different authors. Stebbins (*l.c.*) first made the combination as *Sorosseris umbrella* (Franch.) Stebbins based on the basionym *Crepis umbrella* Franch. – a Chinese species. Later Lipschitz (*l.c.*) proposed another combination as *Stebbinsia umbrella* (Franch.) Lip. based on the same taxon *Crepis umbrella* Franch. This species is quite distinct from the other species of *Sorosseris* Stebbins having more than 15 florets per capitulum, and inner involucre bracts more than 10, as compared to the other species of *Sorosseris* where only 4-5 florets per capitulum, and only 4 inner involucre bracts are present.

During the course of the study, and identification of some members of the Asteraceae, the authors came across some specimens at the Central National Herbarium, Botanical Survey of India (CAL), which had been collected from the Sikkim Himalaya, and incorporated as *Youngia depressa* (Hook. f. Thoms.) Babcock & Stebbins (= *Crepis depressa* Hook. f. Thoms.). Critical study revealed that the specimens Cave 431 and Cave 585 (CAL) are truly *Stebbinsia umbrella*. Thus, this is a new record for India from the Sikkim Himalaya, and an extension of distribution of the Chinese species to the south-west.

A detailed description and its present nomenclatural status, along with the illustrations are presented in order to facilitate its identity.

*Stebbinsia umbrella* (Franch.) Lip. in 75<sup>th</sup> Anniv. Vol. Sukatsch. (New Subtr., Gen. & Sp. Fam. Centr. As.). 362-1956. Grierson and Springate in Grierson and Long, Fl. Bhutan 2(3): 1458.2001, Compositae (Fig. 1).

*Crepis umbrella* Franch. in Morot, Journ. de Bot. 9: 255. 1895.

*Sorosseris umbrella* (Franch.) Stebbins in Mem. Torrey Bot. Club 19(3): 36.1940.

Stem rhizomatous, 4-18 cm high; lower part covered with cataphylls. Upper leaves rosulate, broadly ovate to orbicular (rarely oblong-elliptic), often lyrate-pinnatifid with 1-2 small lateral lobes; 1.5-9 cm x 1-7 cm, apex obtuse to subacute (younger acuminate), margin lacinate-denticulate, base rounded to weakly cordate, herbaceous, rather fleshy, veins depressed above and raised below with prominent reticulations, more or less hairy, particularly towards base and lower surface; petioles 2-12 cm x 0.2-0.5 cm, thickened

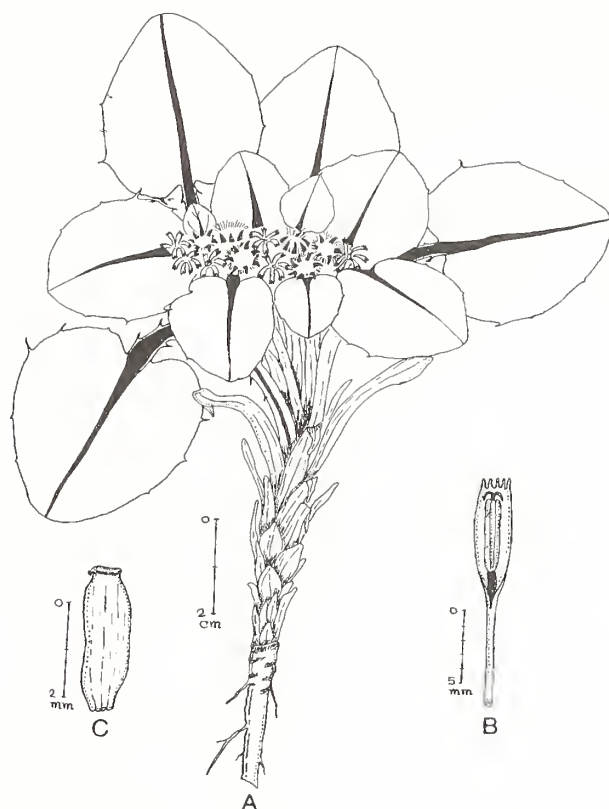


Fig. 1: *Stebbinsia umbrella* (Franch.) Lip.: A. Habitat; B. Floret; C. Cypsel (drawn by D. Maity from G.H. Cave 585 – CAL)

dorsally, with winged nature and denticulate edge, hirtellous. Capitula many, up to 50, corymbiform, amongst the rosulate leaves; peduncles slender, 1-10 cm long, bracteate; bracts leafy, but smaller. Heads cylindric to more or less campanulate, about 10 mm in diameter.; involucre bracts biserial; outer 2-5, linear-lanceolate, 3-10 mm long, imbricate with scarious margins, dull-green to blackish; hirtellous to hispidulous on outer surface along midrib, ciliate at apex. Florets 15-43, all ligulate, 8-20 mm long; ligule 5-toothed; tube slightly shorter than ligule. Pollen echinate. Cypsel oblongoid to somewhat fusiform, 3-6 mm long, apex truncate without neck, but with broadened, flattened annular pappus disc, slightly striate, glabrous. Pappus multiserial, 8-11 mm long, barbate, golden-yellow to white, deciduous.

**Fl. & Fr.:** July-September.

**Distribution:** INDIA: Himalaya: Sikkim; Bhutan; Tibet; China.

Grows on open alpine slopes at 3,640-5,140 m.

**Specimens examined:** Sikkim, without any precise locality, *s.d.*, *GH. Cave* 431 (Acc. No. 255171-CAL) and *GH. Cave* 585 (Acc. No. 255170-CAL).

Note: *Stebbinsia umbrella* resembles *Youngia depressa* (Hook. f & Thorns.) Babcock & Stebbins in morphological appearance, ligule and pollen characters, but here our identification is confirmed by the presence of

neckless cypsela with a truncate apex. Moreover, the cypsela is distinctly ribbed in *Youngia*, but in *Stebbinsia*, it is smooth to slightly striate.

#### ACKNOWLEDGEMENT

We thank the Joint Director, Botanical Survey of India, Kolkata for permission to consult the herbarium.

### 26. PASSERINE BIRD-POLLINATION IN THE DRY SEASON BLOOMING *BUTEA SUPERBA* ROXB. (FABACEAE) IN THE EASTERN GHATS<sup>1</sup>

A.J. SOLOMON RAJU<sup>2,3</sup> AND S. PURNACHANDRA RAO<sup>2,4</sup>

<sup>1</sup>Accepted February 07, 2005

<sup>2</sup>Department of Environmental Sciences, Andhra University, Visakhapatnam 530 003, Andhra Pradesh, India.

<sup>3</sup>Email: ajsraju@yahoo.com

<sup>4</sup>Email: sprao999@yahoo.co.in

The genus *Butea*, as the name implies, produces beautiful orange-red or scarlet flowers. There is very little information available on the floral biology and pollinators of *Butea* species. Ali (1932) reported that *B. monosperma* flowers produce a large amount of nectar and that different passerine birds collect this nectar to quench their thirst during the dry season. He also suggested that *B. superba* flowers are structurally similar to *B. monosperma* and would probably also be ornithophilous. But he has not made any observations on the floral characteristics and pollinators of *B. superba*. Therefore, we studied some aspects of the floral biology and pollinators of *B. superba*.

*Butea superba* is a gigantic woody climbing shrub, occurring in moist localities in the Eastern Ghats forests in the Visakhapatnam and East Godavari districts of Andhra Pradesh. We studied the trees in Lotugedda, Lambasingi and Anantagiri in the Visakhapatnam district and Ramavaram, and in Addateegala in East Godavari district. Floral events – anthesis, anther dehiscence, nectar volume, stigma receptivity and exposure of stamens and stigma were carefully observed according to Dafni (1992), and Solomon Raju and Subba Reddi (1994). Fifty flowers marked on ten different trees were used to observe these events. The flower-visitors included birds, squirrels and monkeys, whose flower-visiting schedules, probing behaviour and role in pollination were observed using binoculars.

*B. superba* sheds its leaves before the onset of flowering, which occurs during late February-March. The flowers, grouped in threes, are borne on a velvety, dark maroon racemose inflorescence. Their maturation and subsequent anthesis does not show either an acropetal or a basipetal

pattern. The flowers are large, 59 mm long, orange-scarlet, bisexual, and zygomorphic. The calyx consists of five sepals, united into a cup-like structure. The corolla has five unequal petals, covered with silky hairs. There are the standard petal, two smaller wing petals and a much curved, beak-shaped keel, formed by the fusion of two petals, which encloses the stamens and stigma. Ten stamens – nine united and one free stamen situated below level of united stamens. Anthers yellow, 3 mm long. Ovary springs up from centre of staminal sheath, style 36 mm long, curved at tip, terminating in a simple greenish-yellow stigma. Curved style and stigma overtop anthers of united bundle of stamens. Ovary unilocular, 4-7 ovules (mostly 4-5).

The flowers open between 0530-0630 hrs. Anther dehiscence is seen thirty minutes after anthesis. Beginning of stigma receptivity is seen one hour after anther dehiscence. Stigma receptivity lasts for 30 hours. A flower produces  $30 \pm 0.8 \mu\text{l}$  of nectar. The flowers show signs of withering on the third day, and drop off on the fourth day if not disturbed by flower-visitors.

The flowers were visited by many birds, including passerines – *Acridotheres tristis* (Common Myna), *Chloropsis aurifrons* (Gold-fronted Chloropsis), *Anthus richardi* (Indian Pipit), *Nectarinia zeylonica* (Purple-rumped Sunbird) and *Nectarinia asiatica* (Purple Sunbird), and non-passerines – *Psittacula krameri* (Rose-ringed Parakeet), *Psittacula cyanocephala* (Plum-headed Parakeet), *Loriculus vernalis* (Indian Hanging-Parrot), *Merops orientalis* (Small Bee-eater) and *Dendrocopos nanus* (Brown-capped Pigmy Woodpecker). These birds collected nectar throughout the day, but they showed hectic foraging activity only during the early morning



and late evening hours. While drinking nectar, the passerines, and *Merops orientalis* contacted the stamens and stigma, effecting pollination. The other non-passerines caused damage to sex organs while probing the flowers for nectar. Further, they made punctures or holes at the flower base to drink nectar and also removed flowers to look for more nectar. Both categories of birds were regular visitors to *B. superba* until the flowers were exhausted. They made frequent visits to other trees of the same species in search of more nectar. The Indian Giant Squirrel (*Ratufa indica*), Bonnet Macaque (*Macaca radiata*) and Common Langur (*Presbytis entellus*) were also found to be regular visitors to the flowers of *B. superba*. The squirrel removed the basal part of the keel petals to access the nectar, thereby destroying the flowers. The monkeys plucked the flowers to eat the nectar-bearing part of the corolla. The flower-eating activity of all non-passerine birds, except *M. orientalis*, squirrels and monkeys were found to be detrimental to the reproductive success of *B. superba*.

*B. superba* flowers show ornithophilous floral characteristics (Faegri and van der Pijl 1979) — anthesis during the day, large, odourless robust flowers, bright orange-scarlet corolla, deep-seated, well-protected nectar and ovary, production of copious amount of nectar and the position of stamens and stigma away from the nectar location. The standard petal curves downwards, facilitating easy probing by birds. The keel petal is beak-shaped, holding the stamens and stigma inside, and overtops the other three petals. Further, the orientation and the arrangement of the flowers on the inflorescence help birds to probe them in quick succession.

The leafless state of trees during flowering, makes the flowers more visible, and may help attract bird visitors, even from a long distance.

These bird-flowers attract both passerine and non-passerine birds. The passerine birds and the non-passerine *M. orientalis* effect pollination while probing the flowers for nectar. During probing, the birds cause the release of stamens and stigma from the beak-shaped keel petal and contact them on their beak and forehead. As the birds are far-flying and frequently move between trees of the same species in quest of nectar, they effect both self- and cross-pollination. The other non-passerines are not specialized flower-birds, but use *B. superba* flowers as a liquid source during the dry period, but in the process damage sex organs and also remove a large number of flowers daily, affecting reproductive success. Squirrels and monkeys use the flowers and contribute to a reduced fruit set rate. The hectic flower-feeding activity of non-pollinators on *B. superba* seen in our study appears to be a consequence of reduced or non-availability of their natural food sources due to degraded forest habitats with reduced biodiversity. Nevertheless, *B. superba* flowers serve as potential feeding stations for visiting birds, squirrels and monkeys during the dry season in the Eastern Ghats.

#### ACKNOWLEDGEMENT

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### 27. SYNCHRONOUS SENESCENCE IN NEEM TREES IN BIJNOR AND JYOTIBA PHULE NAGAR DISTRICTS OF WESTERN UTTAR PRADESH <sup>1</sup>

SANJAY KUMAR<sup>2</sup>

<sup>1</sup>Accepted July 12, 2003

<sup>2</sup>Directorate of Plant Protection, Quarantine and Storage, NH-IV, Faridabad 121001, Haryana, India.  
 Email: sanjaykdr@yahoo.co.in

Neem (*Azadirachta indica* A. Juss.) is a polycarpic perennial, medium sized, deciduous tree having medicinal as well as insecticidal properties. It is cultivated all over India but thrives best in the drier climate of the north-western parts,

where maximum temperatures get as high as 49° C (Anon. 1948). The optimum temperature for its growth, however, is 20-30° C. The Neem tree is described as evergreen because new leaves appear at the tips of branches immediately before

or after abscission of old leaves (Mohan Ram and Nair 1996). Thus, the tree shows sequential senescence controlled by internal factors, and the process becomes more prominent during the months of February and March, just before the initiation of the reproductive phase, every year. The abscission of older leaves helps the tree to conserve nutrients that are needed in large quantities during the reproductive phase. Neem trees cannot withstand waterlogged soils, frost and freezing or extended cold conditions (National Research Council 1992); however, they have occasionally withstood temperatures below 0° C in Dade County, Florida (Anon. 1980). Dogra and Thapliyal (1996) have reported that in the dry localities of India, Neem trees may shed all leaves for a brief period and, therefore, appear to be deciduous. The developmental processes, in general, are controlled by a number of phytohormones. Amongst them, auxins, gibberellins and cytokinins prevent abscission, while abscisic acid and ethylene promote abscission of leaves by forming an abscission layer (Dhami and Srivastava 2004).

Synchronous senescence (complete leaf fall), which is a common phenomenon in plants like Grapevines (*Vitis vinifera*), Peach (*Prunus persica*), Poplar (*Platanus orientalis*) and Pipal (*Ficus religiosa*), was also noticed in Neem trees (younger ones and even those more than 50 years old) in Bijnor and Jyotiba Phule Nagar districts of western Uttar Pradesh during the winter of 2003. To observe the phenomenon critically, Neem trees in residential areas, agricultural fields and along roadsides were marked, at four locations in Bijnor district and at five locations in Jyotiba Phule Nagar district. The observations were made at weekly intervals starting from the second week of January 2003 to the fourth week of April 2003. The trees denuded almost completely were considered synchronously senesced, and of them those that failed to bear new foliage were considered dead. The details of trees observed at different locations have been presented in Table 1. The results revealed that 173 trees out of 198 observed (87.37%) exhibited synchronous senescence. Later with the rise in temperature, by the fourth week of March 2003, sprouting of apical, axillary and floral buds was observed all over the growing parts of these denuded trees, and thereafter these trees had the green foliage crown as before (Photographic evidence provided - Eds.). However, 8 denuded trees (4.62%) failed to survive.

It has been reported that there were repeated western disturbances as an upper air system, extending up to 4.5 km above msl, over north-east Rajasthan and Haryana, and over north Pakistan and Jammu & Kashmir and Punjab regions during the last week of December 2002 and throughout the month of January 2003. There was also an induced cyclonic circulation over the northern parts of Rajasthan, Haryana and

**Table 1:** Synchronous senescence in Neem trees in western Uttar Pradesh

Location	Number of trees		
	Observed	Synchronously senesced	Dead
<b>District Bijnor</b>			
Chandpur	28	24	1
Goyali	17	17	0
Phena	31	24	3
Ratangarh	10	8	0
<b>District Jyotiba Phule Nagar</b>			
Amroha	27	26	1
Dhanaura	22	19	0
Gajraula	24	21	2
Naugaon	21	20	1
Shivala	18	14	0
Total	198	173	8
Mean	22.00	19.22	0.89
S.E. ±	2.15	1.88	0.35

western Uttar Pradesh. Consequently, severe cold wave conditions i.e. mean maximum temperature 15° C (7° C below normal), and mean minimum temperature 4° C (4° C below normal) prevailed in the western Uttar Pradesh up to the third week of January 2003. The total rainfall during the month of January 2003 was 22 mm – 4 mm above normal (Anon. 2003).

Since synchronous senescence is governed by environmental factors rather than internal factors (Dhami and Srivastava 2004), during January 2003, the severe cold spell coupled with frosty conditions throughout the month may be regarded as the stress factors, and the commencement of synchronous senescence in Neem trees as strain. In general, the low temperature range results in dehydration and frost injury to the protoplasm; also, the roots of temperate deciduous trees do not absorb sufficient water from soil. As a result it tends to reduce the rate of transpiration loss through abscission of leaves. Thus, at low temperatures, the production of phytohormones in Neem trees alters to save the plant from the adverse environmental conditions, and subsequently Neem trees exhibit synchronous senescence – a tolerance type of stress resistance.

The Neem trees survived severe cold and frosty conditions through alteration in the normal physiology by showing synchronous senescence, where functional capacity decreases and cellular breakdown increases temporarily. The observations made during subsequent years revealed that Neem trees showed usual sequential senescence and not the synchronous senescence. The reason may be that the cold waves did not prolong beyond a week, which were well tolerated by the Neem trees.

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## 28. OCCURRENCE OF A BI-CHAMBERED FRUIT OF THE RED SILK-COTTON *BOMBAX CEIBA*<sup>1</sup>

VIBHAKAR K. PARALKAR<sup>2</sup>

<sup>1</sup>Accepted September 16, 2004

<sup>2</sup>B 001, Gírnar View Apartment, Gokul Angan, Krishna Township, Off Ambadi Road, Vasai (West) 401 202, Thane district, Maharashtra, India.

During an outing at Sanjay Gandhi National Park, Borivli, I observed many fallen fruits of the Red Silk-cotton *Bombax ceiba* under a tree. While examining the fruits my attention was drawn to an abnormal bi-chambered fruit; the laterally formed fruitlet was approximately one third of the original fruit borne in the opposite direction; seeds with silk-cotton were present in both lobes.



Fig. 1: The bi-chambered fruit of the Red Silk-cotton *Bombax ceiba*

■ ■ ■





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